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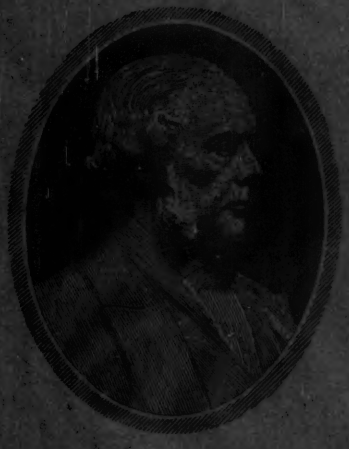

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THE
BRITISH JOURNAL OF SURGERY

VOL. XXXI JANUARY, 1944 No. 123

THE ANGLO-AMERICAN-CANADIAN SURGICAL MISSION TO RUSSIA, JULY, 1943

UNDER the auspices of the Medical Research Council and the British Council, four British surgeons were recently enabled to visit the U.S.S.R. The party was reinforced to its advantage by two distinguished American surgeons. Colonel Elliott Cutler is, of course, Chief Consulting Surgeon to the United States Army, European Theatre of Operations, and one of the finest ambassadors in surgery that the world has known; the other American included in the visiting group was Lieutenant-Colonel Loyal Davis, until recently Senior Consultant in Neuro-surgery E.T.O., U.S.A. The latter is also well known as the editor of *Surgery, Gynecology and Obstetrics*, and as the biographer of the late John B. Murphy; he acted on this mission as the special representative of the Committee of the Medical Research and National Research Councils, U.S.A. Just before the Mission left our shores on the last day of June, a seventh member, a Canadian representative, was most happily added to the group of travellers. Wilder G. Penfield, of Montreal, is Chairman of the Sub-committee on Surgery, Canadian National Research Council, and Director of the Montreal Neuro-surgical Institute. He is as distinguished a scientist as a surgeon.

Rock Carling represented the Medical Research Council as well as Ministries beyond count, and in himself embodied all that is best in British surgery. The experience of Major-General D. C. Monro as Consulting Surgeon to the Middle East Forces for two years made him a valuable member of the Mission; moreover, he had a Scottish ancestry, being himself a great grandson of Alexander Monro tertius and a scion of that famous family of Edinburgh anatomists who continuously occupied the professorial Chair of Anatomy in the Scottish capital from 1720 to 1846. Scotland long ago played an important part in the development of Russian medicine and surgery, and many Edinburgh graduates at one period distinguished themselves in the service of the Czars.

Reginald Watson-Jones represented the Royal Air Force and the orthopædic interests of our country; his tireless, terrific energy, infectious laughter, and boyish enthusiasm for everything and everybody endeared him as much to our Russian hosts as to his colleagues of this very happy Mission.

Elliott Cutler and Penfield were fortified for the long journey by the ceremonial presentation of the Honorary Fellowship within the precincts of the Royal College in Lincoln's Inn Fields, the latter receiving additional stimulation by the almost simultaneous awards of the C.M.G. and the Fellowship of the Royal Society, so that he ventured to far distant parts of Asia before returning to the Dominion of Canada.

The preliminary note from Moscow which rendered this Mission possible was couched in terms of an invitation to come and observe the methods of "treatment of compound fractures due to enemy missiles". The Soviet surgeons, however, exhibited no desire to frigidly restrict the orbit of our surgical observations and discussions, and eagerly displayed to us every group and variety of injury encountered in warfare, and within some of the institutions and hospitals of Moscow we were even shown patients and operations for conditions which were very remotely related to the 'war effort'! We cannot be sufficiently grateful to the People's Commissar for Public Health for the U.S.S.R., G. A. Miterev, who granted us every facility to see whatever we desired, and during his temporary periods of absence from Moscow his Deputies, S. A. Kolesnikov and V. V. Parin, were no less indulgent towards us.

Thanks to the courtesy of Lieutenant-General Smirnov, the Director of the Red Army Medical Service, a very impressive figure, who drank toasts to our meeting in Berlin, we were permitted to visit a "sorting" hospital and two casualty hospitals on the Vyazma front. A feature of this sorting hospital was the early segregation of groups of wounded according to the nature and site of injury; thus a few miles behind the line the wounded man suffering from, say, a penetrating wound of the head or chest fell into the hands of an expert in that particular branch of surgery within a very few hours of injury, and during the patient's progress to the base and

throughout his whole journey to convalescence he remained under the care of those who were specialists in their own surgical province. The proximity of other special departments in the sorting hospital ensured the assistance of more than one specialist in the case of those suffering from multiple wounding.

The President of the Royal College of Surgeons of England availed himself of the opportunity afforded by our Odyssey to arrange for the conferment in Moscow of the two Honorary Fellowships previously awarded by the Council to Academician Nilgai Nilov Burdenko and Professor Sergei Sergevitch Yudin. The American College of Surgeons followed our example and arranged for Honorary Fellowships to be conferred by Colonel Elliott Cutler on the same two recipients in the Russian Capital. Lieutenent-General Burdenko is Chief Consulting Surgeon to the Red Army. Like his illustrious predecessor, Pirogov, of whom he is an ardent admirer, Burdenko is a great warrior, having served in the Russo-Japanese and the last Great War, when he was one of the Consulting Surgeons to the Russian Army. After an apprenticeship in the laboratory of the famous Pavlov, he devoted himself specially to neurological surgery and was responsible for the creation of the first Neuro-surgical Institute in Russia. He has himself trained a fine school of enthusiastic neuro-surgeons.

Yudin is just over 50 years of age, but his experience is immense. He is head of the huge Sklifossovsky Emergency Hospital in Moscow and has normally eighteen assistants. His first assistant, Petrov, is at the moment Consulting Surgeon to the Black Sea Fleet, and his second assistant, Arapov, to the White Sea Fleet. Yudin and his team have, during the fourteen years of his work in Moscow, removed well over 5000 foreign bodies from the œsophagus and bronchi; he had completed last July 89 antethoracic œsophagoplasties for simple stricture of the gullet, of whom only 2 had died—a truly remarkable record. He prefers to construct the new œsophagus from small gut, which is drawn up subcutaneously as far as the angle of the jaw or mastoid process, a lateral anastomosis between the pharynx and jejunum being effected at a subsequent séance. Yudin has performed more than 5000 operations upon the stomach, of which over 2000 were for perforated peptic ulcer. The organization of the emergency service of Moscow is so remarkable that an ambulance with doctor and sister is despatched from the main hospital or a sub-station nearer the scene of emergency well within five minutes of notification being received at the central hospital. Yudin, therefore, receives the perforated peptic ulcers at an incredibly short time after the catastrophe, and is firmly of the opinion that the treatment *par excellence* for these cases is primary gastroduodenal resection, almost always of the Billroth I type, which in his clinic yields the remarkably low mortality of just over 4 per cent. By far the greater number of the perforations are treated in this way; in the 'bad surgical risk' or late case, where closure of the perforation alone is performed, the fatality is three times as great as from resection. These results are quoted here as indicative of the efficiency of the Moscow Emergency System and the possibility of primary radical surgery in a first-rate hospital with a very experienced staff; it would be disastrous, however, if similar surgical measures were adopted the length and breadth of Great Britain—the mortality of perforated peptic ulcer would swell to a menacing figure. Yudin has performed the operation of total gastrectomy for cancer 100 times, with a mortality of 30 per cent. We had the privilege of witnessing him perform a total gastrectomy for a carcinoma of the cardiac portion of the stomach, and there was no doubt about the 'total' nature of the operation; Yudin divided the crura of the diaphragm and mobilized a sufficiency of œsophagus to enable him to anastomose jejunum to the cut end of the gullet. This patient was in good condition a week later.

The operations for chronic gastric and duodenal ulcer, for which we saw him perform gastric resection, were not the simple exercises that surgeons habitually reserve for demonstration to admiring colleagues; the ulcers were of most formidable proportions and exhibited firm fixation to pancreas or diaphragmatic crura.

He is well aware of the anxieties attending late operations for ulcer-hæmorrhage, when surgery becomes a desperate adventure after frustrated hopes of recovery from medical treatment or hæmostatic transfusion. It was refreshing to read and to listen to his tribute to my old house surgeon and colleague, Major Alan Kekwick, who had introduced him to the technique of 'drip' blood transfusion (Marriott-Kekwick), which greatly improved his results.

His gastric operations were performed under spinal anæsthesia, 1 per cent percaine solution being employed; the diaphragm received additional infiltration with novocain. Yudin is undoubtedly the *most courageous gastric surgeon* I have ever seen. A serious illness laid him low in the beginning of 1942; he had also been thrice wounded in the last Great War, one of the injuries producing a paraplegia which kept him on his back then for nine months. His perfervid patriotism chafed under the restraint imposed upon him in this present conflict by the malady of two years ago, but in June, 1942, he was accepted, to his intense joy, as a Consulting Surgeon at the Front. He at once realized the gravity of the fractured femur produced by enemy missiles and set himself to organize 'femur brigades'. An account of his fracture experience in this war has recently appeared in a contemporary journal. (*Brit. Med. Jour.*, 1943, Nov. 6.)

If reference to a surgeon by means of his initials or by some abbreviation be accounted a measure of his popularity, it is not surprising that Yudin is spoken of affectionately as 'S.S.' He

is adored by his staff; read the beautiful appreciation in the 'Festschrift' number of the *Annals of the Sklifossovsky Institute* on the occasion of Yudin's fiftieth birthday: "Here's to you, 'S.S.', writer, poet, violinist, fisherman, captivating teacher, with your burning patriotism! Here's to you, 'S.S.', dilettante, lover of all things beautiful, with your captivating personality, your attractive broken English! Here's to you, 'S.S.', with your marvellous memory, your honest smile, your marvellous fingers! Here's to you, 'S.S.', one of the greatest Master-Surgeons of the world to-day!"

Professor Frumkin, of the Botkin Hospital, is a genito-urinary surgeon of experience; he spoke of a thousand wounds of the bladder which had come under his notice in this war! His reconstructive surgery for those who had suffered the loss of their external genitalia was brilliant, and the members of the Mission will always remember one patient whose penis had been shot off, but for whom a new penis had been fashioned complete with a new urethra, 'fortified' with costal cartilage within the organ, and now capable of performing every function that a normal penis might be expected to fulfil.

The excellent arrangements for *blood transfusion* in Russia which have already been stressed elsewhere by my colleagues, were under the supervision of Professors Bagdasarov and Bogovmoletz. In the past, the employment of corpse blood for transfusion purposes in Russia has attracted notice in both the medical and lay press of our own country. This practice probably was a transient phase in the history of the organization of blood transfusion in Russia, designed to meet urgent need for blood in an endeavour to settle some surgical problem; and although the machinery for its collection is still present in at least one hospital, this type of blood and this mode of collection has now been superseded by the most modern methods, *perhaps even surpassing in carefulness of ritual those employed in Britain.*

The Nursing Sisters impressed us as grave and dignified, skilful and knowledgeable, and certainly humane. At one large sorting hospital at the Front, where we spent a night, the nursing staff had additional duties to perform beyond nursing. Some of the younger members of what Lord Moynihan once termed "the most gentle profession" were to be seen sawing wood, camouflaging huts, and protecting these with turf, earth, etc. At a very late hour on the night of our arrival and at lunch the next day we were entertained to a first-class cabaret, many of the artists being nursing sisters. The Russian women of the front-line hospitals—these were only a few miles back—are indeed versatile.

La science n'a pas de patrie, nor has surgery any frontiers. Only by free interchange of thought and experience with our colleagues in other lands can the science and art of surgery be best advanced. The recent Allied Surgical Mission to Russia gained much from personal contact with the surgeons of that great country, but there is much that Russian surgery might learn from us, such as our experience with the more recent additions to the sulphonamide saga, the results of treatment with proflavine, propamidine, or penicillin; modern developments in neurosurgical technique; the most recent methods in this war's kaleidoscopic story of the treatment of burns, etc. May a return visit of Russian surgeons to our shores follow our visit to Eastern Europe! May this fresh surgical contact so recently achieved prove the harbinger of further surgical visits and revisits, the installation of 'inter-allied' research scholarships for the surgical workers of the Allied Powers, of exchange assistantships, and of a free interchange of medical and surgical literature between Russia and her Allies in the West! War has brought us together; let us remain united in the Peace.

Considerations of space prevent more than a mere mention of a very few of the very many who so eagerly facilitated our contacts with our Russian surgical confreres, who showed us hospitality in their laboratories and elsewhere, who demonstrated the work of their hospitals, and who interpreted our speeches and questions. Professors Ivan G. Rufanov and Leonid A. Koreisha accompanied us from morn till eve, postponing their ordinary avocations till the night-watches; Professors Friedland and Priorov showed us their fracture work; Professor Propper Graschenko had studied neurosurgery on both sides of the Atlantic and was known to several members of the Mission. We listened to Major-General M. N. Akhoutin on problems of thoracic surgery; we met Academician Sergei I. Spasokukotsky, the doyen of the Moscow surgeons, who was awarded a Stalin prize for his work on pulmonary actinomycosis; Academician Lena Stern most hospitably received us and discussed her work on the treatment of shock by means of cisternal injection of potassium phosphate. Colonels Banaytis and Vorshansky courteously accompanied us on our journey to the Front. The President and the staff of Voks put themselves at our disposal unreservedly.

It is difficult to exaggerate the degree of assistance afforded to the members of the Mission by the British Ambassador, His Excellency Sir Archibald Clark-Kerr, who was most hospitable, helpful, and courteous, and it was a pleasure and privilege to meet the charming, kindly American Ambassador, His Excellency Admiral Standley.

Of the staff of the Embassy the name of Tom Brimelow will remain indelibly fixed in the memory of every member of the Mission; he rehearsed Russian speeches with at least one of us! If the work of one of the Russian surgeons appears to be unduly stressed in this paper, the particular *penchant* of the writer of this note must be held blameworthy. The *organization of the Army medical services is wonderful*, and the *Russian wounded soldier is well served by those to whom he turns for succour in his hour of need.*

GORDON GORDON-TAYLOR.

MILITARY SURGERY IN THE 'MIDDLE EAST'

By ARTHUR E. PORRITT, Lieut.-Col., R.A.M.C.

OFFICER IN CHARGE OF A SURGICAL DIVISION; SURGEON TO OUT-PATIENTS, ST. MARY'S HOSPITAL, LONDON

THE following description of the work and working conditions of a 'Line of Communication' desert hospital (the term 'base' is a misnomer, as M.E. Base was officially South Africa) is based on eighteen months' (March, 1941, to September, 1942) experience of surgery during what have become known as the 'Wavell', 'Auchinleck', and 'Alexander–Montgomery' periods. Apart from the Libyan battlefield, clinical material was also drawn from the Greco-Cretan campaign and, to a lesser extent (and later), from the Abyssinian and Syrian campaigns.

In the Middle East there were four types of 'base' hospital: (1) Buildings in the main cities, either originally built as hospitals or converted from hotels, schools, etc. (2) 'Fully Hutted' hospitals, all patients and departments being under a roof. Of these, there were very few. (3) 'Amenity Hutted', having more wards in buildings than in tents, and (4) 'Minimal Essential Hutted', which possessed only a few huts, had most of their patients under canvas, and embraced by far the majority of hospitals in this theatre of war.

The hospital under discussion was included in this last group.

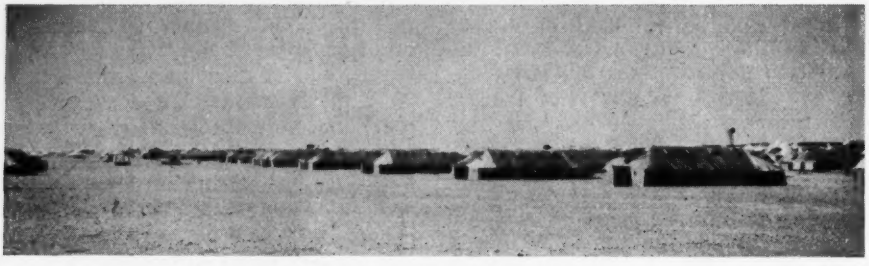

FIG. 180.—General view of original site of hospital—before ward tents were sunk (1941).

FIG. 181.—Officers' lines, etc., on original site of hospital (1941).

FIG. 182.—The Surgical Division of a Field Hospital, M.E., 1941. (Tents—4-section marquees—are all wards, each holding 20 patients. Note group of Italian prisoners used on constructional work.)

I. DESCRIPTIVE

A. DEVELOPMENT

It was sited on a completely bare patch of desert (*Figs.* 180, 181), a mile from the railway

and twenty-five miles from the nearest town of any size. A minimal water supply was available from the first. Despite the inauspicious beginning, cases were admitted (and treated) four days after arrival at the site. Some idea of the state of affairs at this stage is shown in *Fig.* 182. Hospitals of this type, though not mobile, are movable.

Most of the labour involved in this constructional development was carried out by Egyptian labourers (so-called !) and by Italian prisoners of war.

B. WARDS

Ultimately, therefore, patients came to be housed in one of these types of ward :—

FIG. 183.—Part of desert hospital, M.E., 1941. 'Minimal Essential Hutting' shown. (Patients' showers in centre and 'Serious Ward' behind. Tents sunk as protection against blast, and slit-trenched. Group of tents at right, N.A.A.F.I., and beyond this, wall of Sisters' 'Compound'.)

FIG. 184.—Part of Surgical Division of Field Hospital, M.E., 1941. (Nissen huts used as wards, holding 25 to 30 patients. Note "uniformity" of distant view.)

Developments on a new site nearly six months later can be seen in *Figs.* 183, 184. Ultimately, all ward tents, duty tents, and living tents were sunk (3 ft.) as protection against blast and were slit-trenched; roads (tarred) were built around the hospital and paths throughout the 'divisions'; a hot-water supply was installed, providing showers for patients and staff; floors of tented wards were cemented; serious cases were housed in lath-and-plaster huts and later in Nissen huts; in the latter, large electric fans were introduced; a water-tower was built; a limited telephone system was available; electric light was installed in practically every tent and building; an intermittently efficient drainage system was introduced; and in the operating theatres (lath-and-plaster huts) hot-water radiators, extractor fans, and an air-conditioning plant were added, one after the other. A good laboratory (*Fig.* 185) was built.

a. Lath-and-plaster Huts, each consisting of a small ward and several one- or two-bedded side wards (*see Fig.* 183).

b. Nissen Huts, which made excellent, airy, cool wards. Each held 25–30 cases, was equipped with ceiling fans, and protected by a 3-ft. blast wall (*Figs.* 184, 186).

c. Tents: (i) 'Five-section' expanding marquee holding twenty-four patients. (Five-section was found to be the optimum size for the strength of the prevailing wind). (*Figs.* 187, 188.) (ii) 'E.P.I.P.' tents (*see Fig.* 183), which, either singly or linked in groups, made excellent small wards, 'duty rooms', or living quarters.

C. LOCAL CONDITIONS

1. Heat.—The day temperatures varied from around 80° F. in the winter months to 120° F. in the summer. For eight months of the year the noon readings were around the 100° mark,

but the heat was a dry heat and, unless accompanied by dust storms, not particularly exhausting. The fact that for nine months of the year the evenings are cool (a drop of 30–40° was by no means uncommon)—in fact, in the winter months relatively cold—probably accounts for the small effect heat had generally both on staff and patients. Minor degrees of heat exhaustion were not uncommon in the hotter months, and a small series of post-operative heat strokes were encountered. The latter occurred in all types of operation and with a variety of anæsthetics. It was presumed that the victims were naturally thermolabile. Of some 10 cases, only 1 died.

FIG. 185.—Interior of pathological laboratory (lath-and-plaster hut).

FIG. 187.—Interior of standard ward tent. (Note 'floor' of tarpaulin on sand, and mosquito nets.)

They were treated by soaking under a single sheet with cold water, a fan being turned on the bed. Temperatures which had risen within half-an-hour of operation to 105°–106°, fell in an hour or two to the 100° level, a temperature which did not have the same significance as in colder climes.

'Sunstroke' was conspicuous by its absence, but barring emergencies the early afternoon period was not marked by an excessive activity in any section of the hospital life.

2. Sand.—Apart from great outcrops of what is pictured in this country as sand, the desert is floored by a semi-caked surface covered in small stones and fine dust. This dust normally circulates some four inches above the ground, but in a dust storm (these were most frequent in the March-June period)—the so-called 'khamsin'—which is usually accompanied by a scorching hot wind, clouds of this dust rise to considerable heights and in a density which reduces visibility to a few yards and makes the wearing of a respirator quite a reasonable procedure.

FIG. 186.—Interior of Nissen hut ward (Christmas, 1941).

During these storms dust percolates into every nook and cranny, and it is no exaggeration to say that it will fill a closed suit-case! At such times all essential work has to cease—especially in the theatre, but, on the other hand, one definitely formed the opinion that this sand-dust was surgically harmless and, from a practical point of view, relatively sterile. Its presence, however, was one very good reason for the universal use, whenever possible, of occlusive dressings of some sort. These also served to prevent the very deleterious habit of excessive dressings and unnecessary meddling with wounds. Sepsis in clean surgical wounds was very uncommon.

3. Black-out.—In a tented hospital this is a very difficult problem. Black-out was not enforced unless an 'alert' was actually signalled—and was then achieved (after the installation of electricity, supplied first from the X-ray motor and later taken from a main) by a master switch cutting off the whole hospital. Shaded storm-lanterns were then used for essential purposes.

FIG. 188.—'Five-section' hospital marquee, expanding—housing 24 patients (sunk against blast and slit-trenched)—a typical ward tent.

4. Food.—Rations were on the whole excellent, and were backed up by local produce. Eggs

were plentiful and cheap. Fruit of some kind was always available. Only sweet potatoes were supplied for three to four months of the year.

5. Exercise.—The staff found plenty of ways of obtaining exercise. A miniature football league was run inside the unit during the winter months, with relatively few casualties; tennis and deck-tennis courts were made from the desert floor; cricket of a kind was played; riding (on the last of the cavalry horses from Palestine—now used in R.E. Depots) became very popular with sisters and officers; a fencing class flourished for a brief period, and indoors table-tennis, darts, and dancing helped to while away odd moments. One considerable drawback was that the nearest swimming was 25 miles away, but when reached was delightful, the temperature of the water averaging around 80° F.

6. Sanitation.—A very brief sojourn in the East impresses upon one the vital importance of this subject. Constant education of personnel and patients alike is essential, and although the actual fitments (deep-trench latrines, etc.) might be considered primitive in this country, they were practical and efficient. The war on flies was much more continuous than the war on the Axis—and flies were only one of the innumerable things that creep and crawl and fly about which were constant companions in the Middle East—including, at first, both snakes and scorpions!

7. Tropical Diseases.—

a. Dysentery.—This was predominantly bacillary and after the advent of sulphaguanidine it ceased to be a bogy. It is worthy of mention that the effect of sulphapyridine is almost equally good, but this latter drug is, of course, more toxic. Surgical procedure was limited by this disease only to a very minor extent. The ubiquitous "gippy tummy"—almost certainly a low-grade form of bacillary dysentery—caused little trouble apart from its nuisance value.

b. Malaria.—Here again the prevalent type was the 'benign tertian', and its effects on surgical activities were slight.

c. Infective Hepatitis.—Although admittedly not limited to the Middle East, this condition must be mentioned as it was extremely common, occurred in a relatively more severe form than that seen in this country, was most debilitating, and from the surgical point of view definitely negatived any major procedure (other than acute emergencies). Sufferers from infective jaundice proved very bad surgical risks.

D. ADMINISTRATION

The two principal 'Divisions' of the Hospital (Medical and Surgical) consisted at first of approximately 600 beds each. As force of circumstances led to expansion, this number was steadily increased by the addition of extra tentage to approximately 800 beds each. Each Division was divided into six sections of from 100 to 140 beds. A typical section consisted of from 4 to 6 wards (chiefly tents) each containing between 20 and 30 beds. To each section was attached a small tent (4 to 6 beds) used for isolation purposes or very serious cases. Each section possessed its own kitchen and shower house, and was (officially) staffed by one medical officer, a 'charge' sister and four nursing sisters Q.A.I.M.N.S. (one per ward), two or three R.A.M.C. nursing orderlies, and one or two Italian nursing orderlies ('protected personnel'), and two native 'cleaners'. In the latter stages, R.A.M.C. orderlies were being replaced—not altogether satisfactorily—by Palestinian A.T.S. in the proportion of five A.T.S. to four orderlies. It will be seen from the above that the nursing sisters were responsible for the care of three times the number of patients looked after in the average civilian hospital by any one nurse. It must be remembered, however, that unlike a civilian hospital, they had the assistance of orderlies of various sorts, but no words of praise can be too high for the cheerful, efficient, and hard work put in by these sisters in conditions which, to say the least of it, were far from luxurious.

The medical officers' work was also strenuous, as apart from the clinical care of over 100 patients each, they had to complete all the papers concerned with their cases (no mean job in the Army) and also had other duties. In the Surgical Division the six officers were respectively the three Surgeons, the Eye Specialist, the Ear, Nose and Throat Specialist, and the Transfusion and Sanitation Officer. The Officer-in-Charge of the Division personally dealt with the Officers' Wards—100 beds or more.

The *Division Office* was housed in the Operating Theatre Hut, and formed the nucleus of the Division. It was staffed by a Wardmaster (Staff-Sergeant), another N.C.O., and a private, R.A.M.C., with the help of specially selected patients when available. The bulk of the 'paper work' was done here, it being considered that the medical officers' work should be essentially clinical and only to an essential degree secretarial! A very efficient and simple system of record-keeping was slowly evolved and proved eminently satisfactory.

Apart from his office duties, the Wardmaster had other multifarious responsibilities. He arranged divisional admissions, transfers, and discharges—no small job when the hospital was taking in convoys of 200 or more patients daily during battle periods—and he was responsible to the Officer-in-Charge of the Division for such things as the discipline of the Division, its sanitation, the state of its tentage, its cleanliness, its losses of equipment and breakages, its 'black-out', its twice daily 'bed-state', and its football team!

Operating Theatre (*Fig.* 189).—This building was made of lath-and-plaster (camouflaged by the unit with sump oil from the ambulances). It conformed to a Middle East pattern, and consisted of three double wings with a central

passage. The front wing housed the Division Office, the Blood Transfusion Department, and the Surgeons' and Sisters' Rooms; the middle wing the two main Operating Theatres, the Plaster Room, and an Ear, Nose, and Throat Theatre which was used as a Sisters' Duty Room; and the back wing formed the Physiotherapeutic and Radiological Departments.

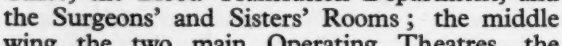

FIG. 189.—Operating theatre (*left*), two tents of surgical out-patients, and corner of administration hut (*right*).

Its construction had many obvious faults, of which indifferent outside lighting was but one, but it served its purpose well and its consistency was fortuitous in that it had to be partly demolished or rebuilt several times to allow of the installation of wiring for electric light, of central heating, of extractor fans, and finally (in one theatre) of an air-conditioning plant.

SPECIAL DEPARTMENTS

1. Out-patients.—General surgical out-patients (i.e., from neighbouring camps) were seen in a special tent three days a week (*Fig.* 189); ear, nose, and throat, and eye out-patients in a converted part of the (far too big) standard mortuary hut. This latter also housed the hospital carpenter's shop !

2. Radiological.—In the Theatre Block, equipment and work under the existing conditions were most praiseworthy. Films were often difficult to come by in sufficient quantity, and an efficient method of washing and re-using old films was evolved. The portable set tended to suffer, especially in the early days, from transit across the desert to various wards. Complicated investigations were naturally kept down to a minimum and screening was indulged in only when really essential. This department also ran an extremely useful photographic service—clinical and otherwise.

3. Physiotherapeutic.—Infra-red and ultra-violet lamps were available, also faradic and galvanic stimulation. Equipment for the giving of active exercises was not provided, but to a large extent was soon improvised, and throughout the two years under consideration emphasis was always laid on this aspect, i.e., active movements as against massage *per se*. Two trained masseurs had a full-time job.

4. Blood Transfusion.—This small department, as a minor part of one of the most efficient services in the Middle East, was housed in the Theatre Block. Its relation to resuscitation in general will be discussed later. It contained all the necessary equipment (obtained from Transfusion Headquarters in Cairo) for the taking and giving of blood. A relatively small store of plasma and serum was kept (most of this being used in forward areas)—and a blood 'bank' of some 8 to 10 pints maintained. A donor panel to cope with emergencies was established, all members of the unit being grouped and a large proportion of the personnel of neighbouring base installations. It was supervised by a specially trained Medical Officer and staffed by one Sister Q.A. and two orderlies.

5. Ear, Nose, and Throat.—No ear, nose, and throat specialist was attached to the unit (it having been intended to run this speciality and ophthalmology on the 'group system'—a scheme which, as it turned out, proved impracticable, owing to the distances involved and constant shortage of available transport), and the work, which though not excessive, was steady, was carried out by general duty officers. One ward tent (of twenty-five beds) was reserved for these cases, except in times of emergency, with a specially trained sister in charge. As has been mentioned, a fairly large out-patient department was also run. No special equipment was officially available, but by devious means (and chiefly from captured Italian equipment) a sufficiency was duly obtained.

6. Ophthalmology.—Similar remarks apply to this specialty. The work was done by a general duty officer, with the help of a specially trained sister (when available !). The in-patients were housed in a Nissen hut to avoid as far as possible the menace of desert dust to these cases. Twenty-five to thirty beds were available. A well-attended out-patient department functioned three days a week. No special equipment was available, but an essential minimum was 'garnered' during the course of time.

7. Orthopædic, Thoracic, Plastic, Genito-urinary, Cranial.—Cases in these categories were throughout dealt with by general surgeons, special or dangerously ill cases being segregated as far as possible in covered wards—huts or Nissens. Segregation to special hospitals or units was at the discretion of the Officer-in-Charge Surgical Division, advised as and when necessary by visiting consultants.

GENERAL

1. Equipment.—The general surgical equipment was perfectly adequate without being in any way excessive ! One learnt that all the usual—and quite a number of unusual—surgical conditions met with could as a rule be well dealt with by a relatively simple set of 'general' surgical instruments. There were no special instruments. Rubber goods kept remarkably well in cupboards with perforated shelves and a receptacle of paraffin at the bottom.

2. **Drugs, Dressings, etc.**—The supply of these naturally varied with transportation difficulties, but on the whole was surprisingly good. The sulphonamides (with the exception of sulphanilamide) were severely rationed throughout; oily media (liquid paraffin, cod-liver oil, etc.) were usually hard to come by, and sporadic shortages in such essentials as atropine, quinine, and surgical spirit occurred.

Training

Throughout the two years in the desert, training of nursing orderlies, of operating-room assistants, and of special orderlies (e.g. ophthalmological, ear, nose, and throat, blood transfusion) went on steadily, courses of lectures, practical classes, and examinations being held at regular intervals. Medical officers and nursing sisters shared these duties.

Research

Considering the relatively unfavourable environment and conditions, a considerable amount of original work was carried out in this desert hospital by its medical officers—a fact which typified the excellent spirit of the Corps as a whole in the Middle East.

E. VOLUME OF WORK

Cases were admitted either from neighbouring camps, from ambulance trains, or as transfers from other medical units.

Local Admissions.—These varied greatly according to the density of population in surrounding camps. A recently arrived draft from the United Kingdom, a lull in the Western Desert allowing units to be withdrawn temporarily for rest and re-equipment, or a large movement of troops, would greatly swell the numbers admitted through the unit's own reception room (again a tent), but a constant small trickle from surrounding base installations and airfields accounted for a daily admission of an average 15 to 20 cases.

Ambulance Trains.—Ambulance trains provided 200 to 250 cases at a time, approximately 50 per cent of these being stretcher cases. Naturally the number of these varied with the activity in forward areas. In quiescent periods a train a week per hospital was a rough average; during battle periods, a train a day was by no means uncommon.

Inter-hospital Transfers.—These transfers resulted from certain hospitals being detailed and staffed to deal with certain types of case, from some unit having to move its site, or from the general state of the battle zone requiring internal re-arrangements.

The hospital under consideration admitted an average of 30,000 patients a year. Of these, there were 3 medical to 2 surgical, irrespective of forward area activities, i.e. the annual surgical admission was approximately 12,000. Of these latter, battle casualties and non-battle casualties occurred in the proportion of 1 to 2·5—i.e., the average number of battle casualties per annum was 3500. (Compare B.E.F. figures, 1914–18, of 1 battle casualty to 2·1 non-battle casualties.)

Some 3000 operations were performed per year; i.e., 25 per cent of surgical cases admitted were operated upon. This figure is not strictly accurate in that quite an appreciable proportion of cases subjected to surgical intervention had more than one operation.

The ultimate disposal of cases can be briefly (and roughly) summarized as follows: Approximately two-thirds were returned to their units fit for active service, either direct to base depots, or indirectly via a convalescent depot; another 25 per cent were recategorized and employed in the Middle East in base duties; and the remaining 15 per cent were invalided to South Africa, there either to proceed ultimately to the United Kingdom, or to return to the Middle East in due course. The working rule was that a case likely to require hospitalization for more than six to eight weeks should be 'invalided'. Naturally this rule was not rigidly adhered to. In times of stress, patients tended to be evacuated sooner, in quieter times to stay longer, and at all times the patient's ultimate welfare was the prime consideration.

F. RECEPTION OF CONVOYS

A brief special paragraph is devoted to this subject for two reasons—first, because of the very important and marked effect the efficient handling of a convoy had on the smooth running of a field hospital; and secondly, because no part of hospital life showed so clearly the excellent spirit and morale that prevailed throughout the Middle East.

To see a convoy arrive at any time of day or night—ambulances and trucks carefully marshalled to their respective disembarkation points (one for walking cases, one for stretcher cases); the patients quickly and quietly brought into the reception tent, each inspected by a Medical Officer and allocated to a definite ward, each having particulars rapidly taken by 'clerks', each being given a cup of tea, a cigarette, and a cheery word before they were whisked away on stretcher or trolley to their desert wards; to see 'guides' leading batches of 'walkers' away to their new desert homes; the ambulances, replenished with blankets and stretchers, driven quickly away across the sand by their native drivers; the transfusion orderlies bustling energetically about, the hospital office staff producing its convoy 'returns' almost before the last patient had left the reception tents, the cooks appearing hot and satisfied with the results of their vastly appreciated work; to see every man, every sister, every officer in the unit doing a willing, cheerful, and efficient job—all this was indeed and always a sight for sore eyes, a sure sign that the spirit of the Middle East forces to get on with the job one hundred per cent was as strong with non-combatant base units as it was away forward in the desert.

The detail of organization for the reception of a convoy was meticulously planned and, as experience increased, steadily improved, until it was certain that the 250 odd cases of an ambulance train could be guaranteed safely in bed, having been medically inspected, welcomed, fed, and officially documented, within an hour (and often much less) of the arrival of the first patient.

It was soon learnt that a resuscitation ward as such was not only not necessary, but a relatively inefficient way of dealing with severe cases. Such cases were given priority in transport to ward tents, were specially labelled, and were attended forthwith by the specially trained transfusion team in the comparative tranquillity of the wards in which they would thereafter be treated. By this means they got more individual attention quicker, and they got to know the staff that was responsible for their future medical care and their fellow patients (all of whom were not, as in a resuscitation ward, in similar dire straits) from the moment of their arrival in the hospital.

On the surgical side, within one hour or two of the arrival of a convoy all new cases had been seen by the medical officers in charge of wards. A meeting was then held with the Divisional Officer, preliminary reports presented, and cases requiring operation divided into three categories —the 'emergencies', the 'serious', and the 'routine'. As experience increased, it was found that the first class got smaller and smaller (there are extremely few cases that are not much better in themselves and much better operative risks for a few hours' rest and such resuscitation as is required); where necessary, they were, of course, dealt with immediately.

On the following day all routine operating was cancelled and the 'serious' cases were all dealt with by as many surgical 'teams' as were available or necessary. The third group became incorporated in the ordinary surgical lists of the division routine time-table. By this means any congestion of cases requiring operation was avoided.

The only other point worth making in this connexion is the vital importance of mutual co-operation between the two divisions—medical and surgical. In times of battle there was frequently a large overflow from a comparatively full surgical division to the medical side. In times of dysentery epidemics or malarial seasons the picture was frequently reversed. Surgical cases in the medical division were under the medical care of the medical officers of that division, and the administrative care of its officer in charge. Surgical specialists were made available to him as required in an advisory capacity.

Similar reciprocal arrangements existed when the surgical division had to house a medical overflow. This scheme worked smoothly and efficiently throughout the two years, thanks to the willing co-operation of the Officer-in-Charge of the Medical Division.

II. CLINICAL

A. GENERAL

The condition of patients arriving from Forward Areas naturally varied directly with the length of the line of evacuation. At times, when the Eighth Army reached Benghazi and farther, it took wounded anything from 10 to 14 days to reach a Base area; for many months the average was about 5 to 8 days, but El Alamein casualties reached the hospital well within twenty-four hours. Such variations materially affected subsequent treatment and constituted a factor which had constantly to be considered. Evacuation of casualties by air increased steadily in 1942 and very rapidly during the El Alamein battle. It produced its own problems in the selection of cases, in the suitability of different types of injury for this form of transport, and in general organization, but there is no doubt many lives were saved by this means.

As a rule, patients were frankly disappointed to discover their Base hospital was still surrounded by illimitable sand, but the relatively quiet conditions obtaining there, and the approximate comfort, very rapidly, in by far the majority of cases, had the desired psychological effect.

Physically there is no doubt the location was eminently satisfactory, and patients' general condition quickly improved. The sickness rate amongst unit personnel for the first year was minimal. A second summer produced slightly higher figures. In general, wounds healed well, and this despite the ever-present sand, and sepsis in primary wounds was a very rare event.

One definitely formed the impression that desert sand, if not bacteriologically, at least clinically, was relatively sterile. However, to exclude as far as possible sand contamination, occlusive dressings were used as a routine. They served also the very useful purpose of preventing unnecessarily frequent and 'inquisitive' inspections of wounds.

Tetanus and Gas-gangrene, especially when compared to the results of the brief campaign in France, were conspicuous by their absence. Protective sera were always given in forward areas, but no case of tetanus was seen during the whole period concerned, and only 4 cases of gas-gangrene. These latter occurred in the El Alamein period, presumably as the battle was being fought in somewhat more cultivated areas than heretofore. Of the 4 cases, 2 were serious (septicæmias), 1 being rapidly fatal.

Blood Transfusions were used extensively, not only for post-hæmorrhagic states, but in the many cases seen amongst the wounded of chronic low-grade toxæmia. Stocks of serum and plasma were small, and these fluids were used only for emergencies. It was found, however, that except in cases of marked blood-loss, great benefit accrued from the use of intravenous glucose saline. In other words, dehydration was a very definite factor influencing the general condition

of patients in such a hot climate. (Transfusion will be further discussed in considering burns.)

Sulphonamides.—These drugs have, of course, revolutionized war surgery, but it is well to bear in mind that they have not replaced surgery.

Regarding their value, protective and therapeutic, when given by mouth, there is probably now no argument. But the same cannot be said concerning their local application, although this was almost universally a routine in the Middle East. An overwhelming majority of surgeons there were firmly convinced on empirical grounds that such application was beneficial. There is no doubt that much further work and controlled tests must be done (and incidentally are being done) before a definite conclusion can be reached. Local application should certainly not be haphazard. A little experience soon taught one to apply measured quantities to open wounds. Sulphonamides applied locally in an oily medium have far less liability to produce toxic effects and their action seems enhanced. This is also so if they are exhibited in an alkaline medium, i.e., 'buffered'. The merest trace of an oxidizing agent with the sulphonamide also greatly increases its activity. These points, on which research is proceeding, were of vital importance when the only sulphonamide readily available was sulphanilamide. Sulphapyridine was usually obtainable in reasonable quantities, but sulphathiazole was chiefly concentrated in forward areas, and sulphadiazine was only beginning to appear at the end of the period under consideration.

It is worthy of note that the least toxic of the sulphonamides when given by mouth—sulphaguanidine—is definitely dangerous if applied locally to a raw surface. In early experimentation a fatality was produced.

In Forward Areas and in most hospitals a small supply of blood already mixed with sulphonamides was available.

Anæsthetics provided several interesting problems. Supply difficulties strictly limited the use of gas and oxygen; the climatic conditions made inhalation anæsthesia of dubious value for general use, and the scope of local anæsthetics was circumscribed. All were used, as was spinal anæsthesia—to perhaps a relatively greater extent than would normally be the case, and particularly in 'clean' surgery. But chief reliance was placed on pentothal, which certainly became the anæsthetic of choice. At least 85 per cent of our battle casualties were anæsthetized by this method—given by an intravenous drip with glucose saline in long operations—and these included all the worst cases. Even in exsanguinated and highly toxic cases no bad results were ever observed, and this anæsthetic was naturally very popular with the patients. In 5000 consecutive administrations, there was only 1 death on the table, and this was in a man suffering from multiple major wounds who was *in extremis* at the time of operation.

B. NON-BATTLE CASUALTIES

Little need be said of these, although it should be remembered that they produced more than two-thirds of the surgical work of the hospital. They included the usual run of hernias, appendices, hæmorrhoids, and varicose veins, which form the backbone of army surgery. It is perhaps worthy of mention, however, that a strangulated hernia was a rarity, that the 'desert appendix' had a bad habit of being of the fulminating variety, and that there is no doubt that heat increases the occurrence and the severity of varicose conditions of all kinds. A remarkable fact was the complete absence of perforated peptic ulcers (and it is noteworthy that even on the medical side gastric cases formed a very small proportion of the total).

For the rest, genito-urinary cases, fractures and sprains, minor orthopædic cases, burns, and superficial infections (so delightfully labelled in the Army—"I.A.T."—inflammation of areolar tissue) produced the bulk. Renal and vesical calculi were surprisingly uncommon, but *renal colic* (from the crystals of highly concentrated urine in relatively dehydrated patients) was very frequent.

'*Desert sores*' formed quite a large group amongst the minor cases. In a very small minority of cases these were due to the diphtheria bacillus (when they healed magically after the application of specific serum), but usually the infection was a mixed one and their salient feature was their chronicity. Almost every available substance was applied to them and each had its advocates. Cleanliness and superficial protection probably did as much as any local application in producing belated healing.

Ear, nose and throat cases were chiefly 'running ears', either otitis externa or otitis media. Sinusitis of one form or another formed the next biggest group. As a general rule, enlarged tonsils *per se* were left in situ, but if considered responsible for other conditions, were dealt with. Mastoiditis was very infrequently seen. Careful cleansing and the insufflation of sulphanilamide powder usually accounted for the discharging ear in a reasonably brief period, but the recurrence rate in the desert was very high. This was to some extent dealt with by teaching the patients themselves the rudiments of careful aural hygiene.

Eye cases were very varied. Injuries and conjunctivitis accounted perhaps for the majority, although irritations from sand provided remarkably little serious trouble. A considerable number of cases of trachoma were seen in native troops—not one definitely in British troops.

Amongst the sporadic rarer and more interesting cases which occasionally relieved the monotony of the staple 'surgical diet' may be mentioned carcinoma of the rectum (2), carcinoma of the colon (1), thyroid enlargement, cholecystitis and gall-stones, seminoma of the testicle (5), empyemata, ruptured livers and spleens, intestinal

obstructions, leprosy (1), and the continued, but usually unavailing, search, again only in native troops, for bilharzia, either in the rectum or the bladder.

C. BATTLE CASUALTIES

1. General.—The following remarks are the result of experience with approximately 5000 battle casualties during the period under consideration. Some generalizations with regard to these wounds may be of preliminary interest. From figures recently published for an eighteen-months' period of Middle East warfare, the wounded accounted for 37 per cent of the casualties (excluding prisoners of war) as against 12 per cent killed and 51 per cent missing. These figures again correspond to a remarkable degree with the 1914-18 result. One might have thought that the vastly more mobile type of warfare as seen in the desert, when compared to the massive frontal attacks of the trench warfare of the last war, should produce a relatively smaller proportion of killed and wounded, but presumably the greatly increased lethal power of modern weapons and explosives has levelled up the balance. There would seem to be little doubt that, particularly in tank units, the proportion of officer casualties is considerably increased in this war.

The type of wound has also, generally speaking, changed. Bullet wounds are in a distinct minority as compared to 'explosive wounds' (from mines, shells, bombs, grenades, etc.), and, correspondingly, multiple wounds are much more common than single wounds. On the other hand, a considerable majority (62 per cent) of the wounds can be classified as minor. Of the remaining 38 per cent, approximately 24 per cent were labelled of moderate severity and 14 per cent very severe. Amongst these latter, tank wounds took easy precedence and in the majority of cases they were combined with burns.

Sepsis, except in the most trivial superficial wounds, was constant even despite the most efficient treatment in Forward Areas; but on the other hand, in the Middle East (in desert warfare) it was a very low-grade sepsis that one encountered, and it would be fair to say that not in more than 10 per cent of the casualties did sepsis *per se* constitute a major factor in treatment. This fact, and the almost complete absence of tetanus and gas-gangrene, must be constantly borne in mind in consideration of the details dealt with hereafter.

2. A Typical Wound.—As experience increased, two tendencies in surgical treatment became more and more obvious—towards steadily increasing conservatism and the standardization as far as possible of routine treatments.

It is necessary to digress briefly into the realms of 'forward surgery', if methods used at the base are to be fully understood.

There are very few wounds met with and dealt with in Forward Areas which cannot, and should not, be considered as 'typical'—and therefore amenable to a standard treatment, i.e., in general, it became increasingly evident that wounds of particular areas (e.g., of brain, major fractures, etc.) should be dealt with on general surgical principles, and that the aim of such advanced surgery should be essentially to render the casualty fit for evacuation as soon and as comfortably and safely as possible. The place for specialized treatment is the base hospital. Obvious emergencies, which demand more radical treatment, were the sucking wounds of the chest and penetrating or perforating abdominal wounds. Treatment forward can therefore be summarized very briefly under the following headings:—

a. Resuscitation.—The giving of blood, serum, plasma, salines; anti-tetanic and anti-gas-gangrene serum; the use of sedatives and oxygen; the provision of sufficient, but not excessive, warmth.

b. Sulphonamides.—By mouth, and, where necessary, used as a local application in measured quantities.

c. Wound Toilet.—This latter word is used advisedly, as it was considered that much better results were achieved by a careful cleansing of the wound rather than by a radical planned excision, even in early stages, and it should be remembered that in the Middle East the average time between a man being wounded and his receiving surgical treatment was fifteen hours. Therefore, a wound was toileted by the removal of a maximum $\frac{1}{8}$ in. of skin, of as much subcutaneous tissue as was accessible, of any obviously devitalized or loose pieces of fascia or muscle, of all completely separated bone fragments, and of any foreign bodies met with in the course of this operation, but not deliberately sought for as such. The wound having been thus cleaned, must be relieved of all tension (e.g., by cutting tranversely across fascia lata in thigh wounds) and drainage ensured, if necessary, by counter-incisions. Tubes and rubber tissue are, in general, to be deprecated. The wound should never be sutured. It is dressed with sulphonamide powder and very loosely packed with vaseline gauze.

d. Immobilization—if possible, by split, padded plasters, e.g., forearm and hand, leg and foot. Wounds of the upper arm are best immobilized by fixing the arm to the chest wall (the U-plaster), and of the thigh by a Thomas's splint. Hip and shoulder spicas were soon found to have little place in war surgery, at any rate in advanced areas.

Wounds treated on these lines arrived at the base in surprisingly good condition, considering the usually very lengthy lines of communication. The more extensive the surgical intervention forward, and the less satisfactory the immobilization of an injured part, the worse was the patient's condition on arrival.

At the Base, such wounds as required it (many were well on the way to being healed when first seen after the 'travelling interval' of a week to ten days) were dressed on exactly similar lines,

there being practically no risk of spreading infection in wounds primarily treated in this manner (cf. the radical excision forward limiting the scope of any further, and often necessary, surgical intervention at a later date).

Foreign bodies were dealt with as follows :—

i. If met with in the course of a wound toilet, they were naturally removed.

ii. If of sufficient size (empirically, " larger than a little finger-nail "), they were localized and removed. The Base and not the Forward Areas is the correct place for dealing with this type.

iii. All others were left in situ until 8 to 10 days had elapsed. By this time the majority of such wounds had healed, but if discharge persisted or there were definite symptoms, e.g., nerve pressure, the foreign bodies were carefully localized and removed.

The temptation to dig out every foreign body is one that should be strongly resisted. By the adoption of the above conservative technique, it was considered that an enormous amount of unnecessary hospitalization was avoided, and a very great saving of valuable surgeon's time.

While one feels that there is no field for primary suture in war wounds, there is certainly a very extensive one for *secondary suture*, and this method was used on innumerable flesh wounds, particularly of thighs and buttocks, with great success at about the 10- to 14-day period. The other great advance in the general treatment of wounds was the use of the *early skin-graft* where secondary suture was impracticable ; at about the same period, the majority of our flesh wounds, irrespective of the presence of a broken bone, were grafted. Most of these were still producing a purulent or seropurulent discharge. Those which grew streptococci were somewhat less favourable ground to work on, but the presence of even this organism did not contra-indicate grafting. If the wound was still frankly purulent, pinch grafts were used ; if the discharge was watery a Thiersch graft was applied. In both cases the wounds were powdered very lightly with sulphonamide dust previous to, and after, the application of the grafts and saline-moistened dressings applied. These procedures were not carried out by plastic surgeons but by all concerned, and one could reckon to obtain success in two-thirds of the cases so treated. The results had to be seen to be believed, and the enormous surgical economy involved will be readily appreciated. In the last nine months of the period under consideration, during which these methods were used, it is estimated that some 20 to 25 years of patients' hospital days were saved.

Before discussing, from the general surgeon's point of view, the more specialized types of wound, a few words on the policy of segregation of special cases may not be out of place. In the Middle East head, chest, plastic, and orthopædic centres were early in existence and efficiently established. To a less well-defined extent, burns, genito-urinary, and rectal centres existed. Naturally none of these centres could cope with all the cases of the specialty concerned occurring in the Middle East, and the question of selection soon became an important one. Nobody will deny the great benefit that must accrue to a patient suffering from one of such lesions in coming under the care of a team of specialists in this particular subject. On the other hand, practical considerations, chiefly of transport, in the Middle East demanded that cases of all types should be delivered in batches to general hospitals. At first, segregation—often involving further long journeys for very seriously ill cases—was decided by special labels applied to patients in forward areas often by relatively inexperienced surgeons. The fallacies of this method were soon obvious, and the Consulting Surgeon, Middle East, ruled that Officers-in-Charge of Surgical Divisions in general hospitals should decide which cases should be sent to a special centre and when they should be sent. This method, in general, worked most efficiently, and there is no doubt that a large amount of most valuable work was done by these special centres on carefully selected cases. When the patient was too ill to be transferred to a special hospital, the services of the specialist concerned were obtained at the parent general hospital.

It cannot be too strongly emphasized that in general the specialist units are most usefully employed at the Base. Particularly is this so where air evacuation of casualties is available. In the early days in the Middle East several specialist teams were sent forward as an experiment, but whilst their general work was excellent (probably two of the best general forward surgeons during the first two years of the campaign were, respectively, a cranial surgeon and a gynæcologist), their opportunities of practising their own particular branch of surgery were so limited as to make their presence in this part of the field a waste of surgical efficiency.

3. Orthopædic Surgery.—As approximately one-third of the total number of wounded have bones and joints involved, any complete segregation of orthopædic cases was impossible. Nevertheless, it can be said that the treatment of these cases was on the whole very satisfactory and showed steady improvement. It has been pointed out above that in forward areas a broken bone should only be considered as incidental in a wound. Any meticulous ' setting of a fracture ' at this stage should be discouraged. Careful and efficient immobilization of the limb (after the wound has been treated according to the general surgical principles enunciated above) is the ideal to be aimed at.

At the Base the position of the bones in the fracture must be corrected at the time the wound is first re-dressed. Correction may be achieved by careful manipulation, by open reduction if the fracture site is already exposed in the wound, or by skeletal traction. The tendency to overdo skeletal traction in compound fractures was one

that had constantly to be watched, particularly in wounds which involved the loss of considerable portions of bone. Pins, and generally speaking the Steinmann pin was found to be preferable to Kirschner's wire for fractured femora, were inserted through the upper anterior tibia as a general rule. Pins through the os calcis were not favoured if any other method was available. Immobilization by plaster-of-Paris was the usual method employed, except for fractured femora, where the Thomas splint, with attached leg-piece, more than held its own. Braun's splints were used, but to a very limited extent. The recording of minimal essential clinical data, i.e., date and type of wound, date and nature of last treatment, with, if possible, a pictorial representation of size and site of wound, on the outside of plaster casts, was a practical point of the greatest assistance to medical officers during both evacuation from Forward Areas and the subsequent prolonged treatment, often involving the moving of a patient through a series of hospitals. These so-called 'plastograms' saved an enormous amount of hunting through an ever-increasing pile of miscellaneous documents.

The very rapid rate of union in compound fractures of the long bones was a never-failing source of surprise and satisfaction. It was definitely exceptional for a compound fractured femur not to show quite reasonable clinical union within six weeks, and this period was considerably shortened after the first year by the concomitant use of skin-grafting as described above. A successful graft very markedly reduced the amount of discharge and bony union was appreciably accelerated.

Amputations.—There seems little doubt that the number of amputations performed in this war is relatively far less than in the last. The figures in this particular hospital worked out at 5 per 1000 battle casualties. In a series of some 30 cases of suppurative arthritis of the knee-joint only 1 amputation was performed. Obviously the sulphonamide group of drugs is to a considerable extent responsible for this dramatic change. It remains to be seen whether the function of the limbs saved from early amputation justifies the present conservative outlook, but the policy followed was to make amputation essentially only a life-saving measure. It was considered that providing healing could be obtained and the patient's general condition maintained, all limbs should be saved irrespective of their probable future function. If this ultimately proved to be less than could be produced by the use of a well-fitted artificial limb, then at that time a carefully-planned 'cold' amputation could be carried out.

For the emergency amputation, i.e., in a limb devitalized by the original injury, certain standardized rules were in force. If a limb has to be amputated, then the tourniquet should be applied as distally as possible and should not be removed until it comes away with the distal portion of the amputated limb. (Incidentally, it is felt that apart from this use, the less in general a tourniquet is used the better.) Emergency amputations should always be at the most distal level possible. As every wound is potentially if not actually septic, there is no justification for a primary amputation at the 'site of election'. Some subsequent 'trimming' of the stump will almost certainly be required, and if the site of election was used in the first instance, this trimming may result in a stump to which it is difficult, or impossible, to fit an artificial limb.

Every amputation should be planned. A guillotine amputation is a surgical crime. But in a primary emergency amputation, the skin-flaps must never be sutured. At the most they should be held together with one or two interrupted silkworm-gut sutures. It is probably better to leave the flaps wide open or even suture them back to more proximal skin. In many cases secondary suture can be safely and satisfactorily carried out.

4. Thoracic Wounds.—The position in regard to penetrating wounds of the chest in the Middle East was considered to be increasingly encouraging. In a general hospital it was soon obvious that relatively larger numbers came back from the front in each successive engagement, and a rather sweeping generalization soon became an accepted dictum on the position, viz., that of those cases which safely reached the Base (and it remains to be seen what proportion were killed outright) nine out of ten would recover with conservative treatment (aspiration of the accompanying hæmothorax with or without—and usually without—air replacement, sulphonamides, and transfusion as required), and provided no further surgery was indulged in. The remaining one case in ten was for a thoracic unit, and his chances were just better than 'fifty-fifty'.

This summary of the chest situation is probably rather drastic, but it serves to show that this group of cases produced on the whole surprisingly satisfactory results.

The assistance of one's medical colleagues was always most valuable in dealing with these cases, which, incidentally, accounted for approximately 3 per cent of the battle casualties dealt with in this particular hospital.

Secondary empyemata were distinctly uncommon. That the immediate covering of a 'sucking' wound is a life-saving measure was proved by two cases which somehow slipped through the 'forward surgical net'. One, a Guards officer, travelled ten days from Benghazi with his 'sucking wound' blocked by an obliquely lying piece of shell-casing measuring $2\frac{3}{4}$ in. by $3\frac{1}{2}$ in; and the other, a sapper from forward of El Alamein, with a pad of wool covering the aperture into his pleura, stood a three-day journey remarkably well. Both were treated on general surgical principles as set out above, except that the wounds were closed by interrupted sutures. Both recovered.

5. Head Wounds.—Head wounds as seen in a Base hospital accounted for slightly more cases

than chest wounds, viz., 4 per cent. Again, the relative number of head injuries killed outright remains to be discovered, but of those who lived to obtain treatment, it can fairly be said that like the chest cases a surprisingly large and satisfactorily increasing number did remarkably well.

The initial treatment received forward was of the greatest importance and can be summed up as careful toilet of the wound, minimal and very gentle interference with brain tissue, the use of sulphonamides both locally and by mouth, and light suturing of the scalp to prevent hernia cerebri. It was considered that specialist treatment for these cases was of great importance, and on arrival at a general hospital, except for those which were obviously recovering rapidly, they were treated symptomatically until sufficiently recovered from their initial journey of evacuation to be fit for transference to a 'head centre'. During this period there was a small mortality, but it is felt that without the period of rest in a general hospital, this would have been materially increased.

It is worthy of note that a conservative policy with regard to intracranial foreign bodies appeared to pay handsomely, and in this connexion it should be stressed that secondary cerebral abscesses were found to be due to small pieces of bone far more frequently than to metallic fragments.

It was customary to nurse head cases in the 'semi-sitting-up' position, except for the small minority with low blood-pressure, in which this produced very severe headache.

Two instances were met, in cases of multiple peppering wounds, of minute metallic fragments entering the base of the skull (? through existing foramina) and producing, long after the scar of the original wound was practically invisible, delayed cerebral abscess, in both cases fatal.

6. Abdominal Wounds.—Unlike the chest and head wounds, those of the abdomen continued to produce disappointing results during the period under review. It could fairly be said that at the end of the eighteen months more abdominal wounded were getting back to Base hospitals than at the beginning of it, but the numbers were relatively very few. The cases accounted for no more than 1 per cent of the admissions to the hospital concerned.

It was felt that in comparison with results of the last war, there was really very little improvement, and what there was could probably be accounted for by the use of the sulphonamide drugs.

It is cheering to be able to state that from preliminary reports since received, it would appear that in the most recent campaign—the advance from El Alamein to Tunisia—a very definite amelioration of this position has occurred. This can probably be put down to several factors: viz., the development of the Field Surgical Unit as a functioning entity, allowing earliest attention to these cases and the possibility of holding them after operation for anything up to ten days; the availability of beds as against stretchers in which to nurse them; the use of sulphadiazine as a specific intraperitoneally, of pre-operative and post-operative transfusions and infusions, and perhaps, above all, of post-operative intestinal suction drainage.

A point worthy of note was the increasing and obviously beneficial use of the original perforating injury of the large gut as a colostomy, i.e., wherever possible simply exteriorizing the damaged loop without attempt at primary repair. Of treatment of these cases at the Base little need be said. It involved simply good nursing and such symptomatic measures as were indicated in any particular case. Those which reached this hospital, with one exception, were able to be evacuated, though usually after a stormy convalescence. None remained long enough to make any assessment of final results possible.

7. Burns.—Burns accounted for approximately 7·5 per cent of the battle casualties admitted to this hospital, and for every battle-casualty burn in the Middle East there were two accidental cases. The ability of the British Tommy to discover multifarious, and usually dangerous, ways of using petrol is beyond belief. The battle-casualty burns came chiefly from the Tank Corps and were, more frequently than not, serious, being usually combined with a wound.

These figures should not be taken as generally representative of the occurrence of burns, since this hospital during the latter part of the period under discussion became a 'Burns Centre', and hence had a relatively high proportion of these cases.

During the Wavell period practically all burns were tanned in forward areas. The results were depressing in the extreme. Nine out of ten arrived at the Base septic and in very poor general condition. All that could be done for them, often after very necessary resuscitation, was to remove this septic tan. To the raw areas so produced, a variety of available substances were applied in an attempt to discover which would produce the most rapid healing. The three most satisfactory *individual* substances proved to be sulphanilamide powder (alone), cod-liver oil (then available), and vaseline. It was then decided to try combinations of these, and it was found that a suspension of sulphanilamide powder in the oil was by far the best application (both for comfort and rapid healing) so far used, and that the powder and vaseline was a good second. The supplies of cod-liver oil soon disappeared, but any thought one might have had that the local vitamin effect was a factor in the success of the suspension was soon negatived by the equally good results produced later by using first olive oil, then cotton-seed oil, red palm oil, and finally arachis (pea-nut) oil.

The conclusion reached empirically, therefore, was that the physical properties of the oil were responsible for the even distribution and diffusion

of the sulphonamide. A further highly beneficial result directly due to the oily base was, as proved by many and repeated blood-sulphonamide estimations, that the absorption into the blood-stream was definitely limited—a very important point when applying the sulphonamides to large raw surfaces.

A lot has yet to be learnt about the absorption rates of the various sulphonamides, but experience has certainly proved that they cannot be applied indiscriminately.

The rapidly extending use of sulphaguanidine in the treatment of dysentery prompted the experiment of applying it to burns—as its toxicity by mouth was, in comparison to its sister drugs, so low. The results were startling, as it produced very rapidly the most alarming toxic symptoms: in one case, at another hospital, a fatality. Thus, it can be said that the oily suspension of sulphonamide enhances and prolongs the local effect, whilst at the same time ensuring a long-lasting but low-level (non-toxic) blood-sulphonamide.

The results of these earlier experiments were so encouraging that through the kindness and enthusiasm of the Consulting Surgeon, Middle East, a full-fledged investigation was set in train, which unfortunately was ended all too soon by the fall of Tobruk. All burns from selected units, the Regimental Medical Officers of which had been specially instructed, were passed down the line of evacuation to our advanced hospital at Tobruk without any attempt at cleaning and without any application other than vaseline. Such general resuscitative measures as were required were, of course, given at (likewise specially instructed) field ambulances and casualty clearing stations. At Tobruk meticulous and gentle toilet of the burns was carried out under general anæsthesia, and wherever comparable burns had occurred on two limbs, to one was applied a 10 per cent silver nitrate tan (the edges being treated after drying with triple dye), and to the other vaseline and sulphonamide. The limbs were then encased in a light, carefully padded and split plaster, and the cases sent down to the Base.

Here we continued the respective treatments until healing occurred; the results proved most enlightening, and a demonstration of a large series of cases proved to the higher authorities that even where both treatments were successful, the vaseline-sulphonamide areas healed from 10 to 14 days sooner than a corresponding tanned area, that the oily dressing was infinitely more comfortable to the patient, and that the residual new skin was a great deal better from a trophic point of view, and function of the limb concerned correspondingly more rapidly regained.

As a deduction from this it was considered definitely wrong treatment to apply tannic acid (and much more so tannafax) to burns in Forward Areas, and an order to this effect was issued to the Eighth Army by its D.D.M.S. in June, 1942. Meticulous surgical toilet carried out under reasonable conditions, and with full anæsthetic facilities, is essential if any success is to be obtained from tanning methods for war burns, and even then the results were not so satisfactory as those obtained by vaseline and sulphonamide.

Apart from this particular series, a large number of burns were treated with the sulphonamide and oil method, applied on the smooth side of lint, the dressing being left unchanged (but moistened daily from the outside by further oil), until either the burn healed or discharge lifted it free of the burnt surface. In this latter group, after about 10 to 14 days, skin-grafting was performed more and more frequently in the latter months, with highly encouraging results.

In all, a series of some 400 cases of burns were carefully investigated, treated, and annotated, and it is hoped in the future, when the notes on these cases have been thoroughly analysed, to produce a more detailed description of the methods employed and the results produced.

Blood transfusion was used extensively in the treatment of these cases, and perhaps one or two points in this connexion are worthy of notice. Plasma is, of course, invaluable in the early stages of a severe burn; in the chronic 'toxic' type great benefit was obtained from the use of 'whole corpuscle' transfusions; and recent work would seem to suggest that the giving of serum up to three weeks from the time of the burn is a method which has not heretofore been sufficiently exploited.

CONCLUSION

The following points may be selected from the above notes as perhaps best exemplifying advances in war surgery as seen in the Middle East:—

The reorganization of, and increased facilities, now given by forward medical units, and in this connexion evacuation of casualties by air must be stressed.

The greatly increased use of blood transfusion methods and the fact of their having been made readily available by excellent organization from front line to base.

The advent of the sulphonamide drugs in all their protean forms, and their use both locally and generally.

The widely extended use of plaster-of-Paris as an immobilizing 'dressing' for wounds of soft tissues as well as fractures.

The value of early skin-grafting at a relatively early stage both for burns and wounds, and as a corollary to this the strict avoidance of primary suture of wounds and the greater use of secondary suture at about the 10- to 14-day period.

The inadvisability of using tanning methods on war burns and the great value and efficiency of sulphonamide-oil or sulphonamide-vaseline combinations.

SUMMARY

1. A description is given of the types of hospital in the Middle East.

2. A detailed account of the development of one of these, and of the conditions under which it worked, is given.

3. The administration of a ' surgical division ' is described.

4. The various departments and equipment of such a division are discussed.

5. The reception of a convoy of wounded is described.

6. Details are given of the volume of work carried out.

7. Consideration is given to the various types of wounds met with (wounds in general; chest, head, and abdominal wounds; burns).

8. The outstanding advances in war surgery as seen in the Middle East are listed.

I should not like to conclude without expressing my very keen and sincere appreciation both of the never-failing help, encouragement, and stimulus given by the consultants in the Middle East and of the cheerful, untiring, and enthusiastic work of the medical officers, sisters, and personnel with whom I had the pleasure to be associated. The spirit which pervaded the Medical Services in the Middle East had to be felt to be appreciated, and one feels it is an honour to have been, for a time, a part of them.

COMPOUND FRONTO-ORBITAL FRACTURES

(EIGHT CASES)

By J. SCHORSTEIN

CHIEF ASSISTANT, NEUROSURGICAL DEPARTMENT, MANCHESTER ROYAL INFIRMARY

INTRODUCTION

At the present time a certain amount of controversy exists as to the need for radical operation in those frontal injuries where the posterior wall of the frontal sinus has been broken without a laceration of the overlying skin. At the time of hospital admission the well-being of the patient may deter the surgeon from undertaking operative steps of some magnitude, and the risk of infection may at first seem remote until some days later a serious and well-nigh irremediable intracranial sepsis gives cause to regret that conservative treatment had been adopted. These cryptically compound frontal fractures were not very frequently seen in civil hospital experience, but have been observed in greater number amongst the military dispatch-riders. Even in these, where, it must be admitted, the percentages of early and late meningitis are not as yet accurately known, some advocate immediate and radical operation and others a watching policy.

There can, however, be no debate about the necessity for immediate operation in the injuries with which this paper is concerned. They are open wounds containing in their depths the broken fragments of the walls of paranasal sinuses and are associated with dural tears. Up to the present no description has been given in the literature of what exactly these injuries are like, and what exactly should be done. The extent and severity of the deep damage in all cases was considerably in excess of that which the external appearances suggested. It is only when one has seen a number of these injuries, has followed the wounds in, has removed the loose fragments of bone, and has dealt with dural and cerebral lacerations that a realization comes of the magnitude of the injury and the task that awaits one. The experience of the present series may find a place in a consideration of the more complex problems concerning the treatment of those fractures of the anterior cranial fossa which without skin laceration are compound into the nose or paranasal sinuses.

Of the 8 cases forming the material of the present communication, the author performed early and extensive operation in 6 cases. In all these the dura had been torn by the trauma and in 4 patients the brain was severely lacerated. Only 1 patient, a child in whom the frontal sinuses had not yet developed, had no sinus injury, but the case has been included as it corresponded in other respects with the adult patients. In 5 of this group of 6 patients the frontal sinuses were broken; in 4 the fracture extended into the ethmoidal cells; and in 4 patients the roofs of the orbits were fractured. All these patients recovered satisfactorily, localized wound infection occurred in only 1 case fourteen days after the injury, and all skin wounds healed by first intention.

The two remaining cases in the present series were seen ten days and five months respectively after they had been injured. Their wounds had received only superficial attention at other hospitals. The extent of the brain injury could not be ascertained in these patients. X-ray films showed that the frontal sinuses and roofs of orbits had been broken; probably the ethmoidal cells were also damaged. In one, cerebrospinal rhinorrhœa occurred and provided evidence that the injury had opened the subarachnoid space. Recovery was delayed and complicated by meningeal sepsis.

A synoptic table follows analysing the features of the individual cases. It must be emphasized again that all these patients had scalp wounds which led directly down to the fractures of the frontal bone.

Table I.—SUMMARY OF PARTICULARS OF THE AUTHOR'S 8 CASES

CASE	AGE	SEX	TRAUMA	BONY INJURY	DURA	BRAIN DAMAGE	REMARKS	GRAFT
				GROUP 1				
1 (J. Y.)	21	M.	Fell 70 ft.	Fracture supra-orbital ridges, fracture both frontal sinuses, ethmoidal sinuses, roofs of orbits	Two lacerations	Pulping R. frontal lobe	Healed per primam. Diabetes insipidus. R. external rectus paresis. Bilateral anosmia. Temporary cerebrospinal fluid rhinorrhœa	Outer skull table 7 mth. after injury
2 (T. W.)	17	M.	Struck by brick	Fracture both frontal sinuses and ethmoidal sinuses	Lacerated	No gross injury	Healed per primam. 14 days after injury had throat infection with hæmolytic streptococci and metastatic extradural abscess at site of injury. Healed after drainage. No anosmia	Outer table graft 21 mth. later
3 (P. W.)	32	M.	Fell off travelling lorry	Fracture anterior and posterior walls R. frontal sinus, fracture R. ethmoidal cells, R. roof of orbit, R. external angular process, and R. infra-orbital ridge	Lacerated	Pulping orbital surface pole of R. frontal lobe	Healed per primam. Blindness R. eye immediately after accident. Anæsthesia R. cornea. No anosmia	None
4 (G. G.)	19	M.	Motor-cycle accident	Semi-circular depressed fracture centre of forehead. Fracture anterior and posterior walls both frontal sinuses, fracture into ethmoidal sinuses, fracture both orbital roofs	2½-in. laceration	R. frontal pole lacerated	Healed per primam. Uninterrupted recovery. No anosmia	Ilium graft 6 wk. later
5 (R. N.)	21	M.	Aeroplane crash	Fracture infra-orbital ridges, fracture L. orbital roof, fracture anterior and posterior walls both frontal sinuses	½-in. laceration	No gross injury	Healed per primam. No anosmia	Outer skull table 8 wk. after injury
6 (J. S. B.)	2½	M.	Run down by lorry	Fracture frontal squama, L. supra-orbital ridge, L. roof orbit. Frontal sinuses not yet developed	1½-in. laceration	Pulping L. frontal pole	Healed per primam. No anosmia	None
				GROUP 2				
7 (L. A.)	26	M.	Motor-cycle accident	Fracture both frontal sinuses and roofs of orbits	Probably lacerated	Presumably damaged	Recovery complicated by encephalitis, meningitis, sciatic neuritis. Bilateral anosmia	None
8 (H. J. G.)	31	M.	Motor-cycle accident	Fracture both frontal sinuses and roof of L. orbit	Presumably lacerated	Unknown	Severe meningeal infection, sciatic neuritis. No anosmia. Temporary cerebrospinal-fluid rhinorrhœa	None

CASE REPORTS

Group I. Six Cases of Compound Fronto-orbital Fracture treated by Early and Extensive Débridement

Case 1.—**Compound fracture of right and left frontal sinus, fracture of ethmoidal sinuses and right and left orbital roofs. Laceration dura. Cerebral laceration. Diabetes insipidus.**

HISTORY.—J. Y., aged 21. This patient was admitted to the Manchester Royal Infirmary under the care of Professor Morley on Jan. 20, 1941, and was transferred to the Neurosurgical Service. He was said to have fallen from a height of 70 ft.

ON EXAMINATION.—A dirty ragged laceration of the forehead ran for about 4 in. parallel with, and a little above, the supraciliary arches, and he bled from both nostrils, the mouth, and the right ear; both nasal bones, the right half of the mandible, the right humerus, wrist, and ankle were all fractured. Since he was in a profound state of shock no detailed neurological examination was carried out, but it was observed that he moved the uninjured extremities in response to unpleasant stimulation. Resuscitation measures were instituted and X-ray films taken about two hours after his admission showed a severe comminuted depressed fracture of the frontal bone which involved the frontal sinuses and the orbital plate (*Fig.* 190). It was decided to operate if and when his condition permitted.

AT OPERATION.—Six hours after his admission he was judged to have recovered sufficiently and the operation was carried out under nitrous-oxide–oxygen and ether anæsthesia, for by that time the patient had become restless. As soon as anæsthesia had been induced his condition deteriorated; the pulse-rate was above 160 and remained at that level throughout

the operation. The wound edges were excised and short incisions were added to the right and left to expose all the fractured bone (*Fig.* 191, A). The

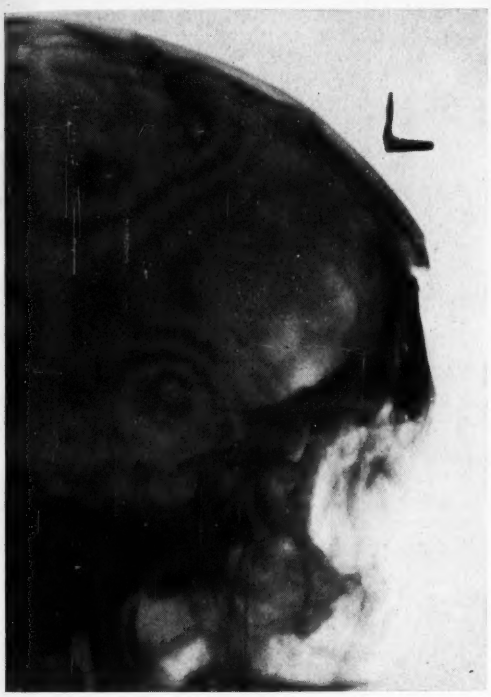

FIG. 190.—*Case* 1. Radiograph showing depressed fracture of frontal bone.

medial third of the left, the medial half of the right supraciliary arch, and the glabella were fractured, as was the frontal squama (*Fig.* 191, B). The fragments had hardly any attachment to periosteum. Once the overhanging edge of undamaged bone above the fracture had been trimmed away, the wedged pieces of broken bone could be removed piecemeal with the aid of cutting bone-forceps. The posterior wall of the frontal sinus was splintered and some of its fragments came away with the anterior wall; others covered by mucosa of the sinus lay on the dura. The medial portions of the supra-orbital ridges loosened by the injury were also removed. The resulting bone defect gave sufficient exposure for elevation of the frontal lobes and inspection of the floor of the anterior fossa with the aid of illuminated retractors. The crista galli and lamina cribrosa could be rocked from side to side and from there comminuted fractures extended backwards and laterally. Removal of the splintered bone with the exception of the lamina cribrosa opened the horizontal portions of the frontal sinus in front, exposed orbital periosteum laterally, and unroofed ethmoidal cells posteriorly. All overhanging bone edges of the frontal sinus were next levelled off and all its remaining mucous membrane removed. The ethmoidal cells on either side were curetted with a sharp spoon and their mucous membrane was grasped with artery forceps and twisted out. Smart bleeding from the anterior ethmoidal artery on the left and the anterior and posterior ethmoidal arteries on the right was controlled by electrical coagulation.

The cavities in the right and left anterior fossæ were now packed off with hot saline swabs. Two tears were found in the dura mater; one a little lateral to, and parallel with, the longitudinal sinus at the junction of base and convexity, and another more laterally and posteriorly. Brain debris oozed from the larger medial laceration. The two openings in the dura were joined and all lacerated brain was sucked away with a narrow-bore sucker until more resistant, presumably viable brain was encountered. The tip of the right frontal lobe and its orbital surface for a distance of about 1½ in. along the base were thus removed.

Bleeding from cerebral vessels, mainly small veins, was stopped by coagulation; two arteries were secured with silver clips. The dural edges were approximated with interrupted sutures, but as each stitch was tied it caused a small dural tear. The skin incision was extended into the right temporal fossa and a free graft of temporal fascia was prepared and sutured over the dural laceration. Insertion of sutures on the basal dura was technically difficult. When the saline packs were next removed from the bony cavities all bleeding from them had ceased. Corrugated rubber drains were placed on either side of the crista galli and brought out through the wound. Sulphapyridine powder was sprinkled into the wound, including the cavity in the frontal lobe (*Fig.* 191, D). The skin was closed in two layers, and where the drains entered, skin sutures were left long and tied after removal of the drains on the second post-operative day. The operation had lasted two and a half hours. It remained to reduce and splint the fractures of the extremities, and to deal with skin lacerations.

POST-OPERATIVE PROGRESS.—For three hours after the operation he made no spontaneous movements,

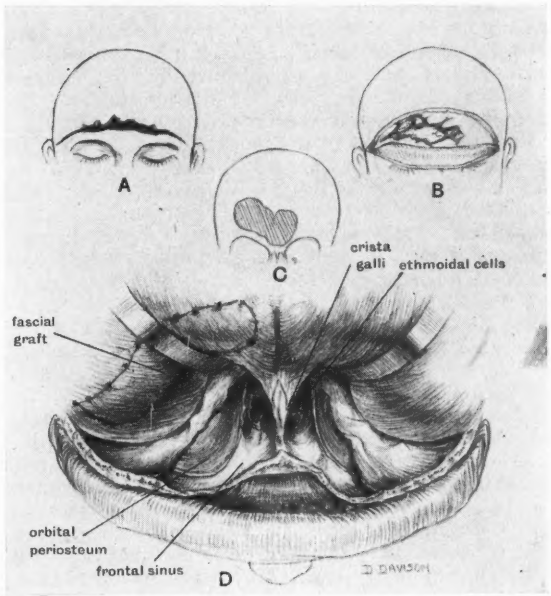

FIG. 191.—*Case* 1. A, Skin wound; B, Fracture after reflection of skin; C, Diagram of post-operative radiograph; D, The operative field prior to closure of the skin.

but from then on and for about nine days he was extremely restless and noisy. In a ward where difficult patients with cerebral lesions form a fair proportion of the changing population, this man set up a new record in obstreperous behaviour. Drops of clear fluid were observed to come from his right nostril on the fourth post-operative day and a slight

rhinorrhœa continued for a week and then ceased. The wound healed without complication. A right external rectus palsy first noticed on the tenth day recovered after about six months. Three months after admission he left the hospital.

On the seventh post-operative day sugar was present in the patient's urine and he drank and passed four pints of fluid. The blood-sugar was 114 mg. per cent. The glycosuria disappeared after a day, but diabetes insipidus became more pronounced and still persisted when he was last seen eighteen months after his accident. It was kept under control with three daily injections of 1 c.c. of pituitrin; smaller doses failed to restrict his water intake, and pituitrin snuff had no effect on his thirst. Twenty-five pints of water was his record intake on one day when snuff had been substituted for the injections.

From about the second post-operative week onward he complained of severe, continuous frontal headache, and encephalography was performed to see if he had a cerebral abscess. The result of this investigation was negative.

Seven months after the operation he was re-admitted and the bone defect was covered with an outer table skull graft. The cosmetic result is satisfactory and his headaches have practically ceased since this last operation. Diabetes insipidus, complete bilateral anosmia, and dizziness are his complaints at present and have thus far prevented him from returning to work.

Comment.—J. Y. was chronologically the first patient in the present series, and of those that followed none was more severely injured or passed through as stormy a period of convalescence. An important lesson that emerged was that operation on a depressed fronto-orbital injury was likely to be more time-consuming and complicated than an operation on a bony injury elsewhere in the skull. Without all the neurosurgical apparatus, particularly illuminated brain retractors, diathermy, and efficient suction, the operating time would certainly have been longer, a serious consideration in so ill a patient. The doctrine that inhalation anæsthesia is badly tolerated by patients who have suffered a brain injury was fully borne out by the experience of this case, and for similar subsequent cases we have employed repeated small doses of evipan or pentothal sodium to supplement the local anæsthetic. This method of anæsthesia is now a routine in the Manchester as well as the Stockholm Neurosurgical clinic. Whilst the roof of the orbit and the mucous membrane of the paranasal cavities are being dealt with, a general anæsthetic is desirable.

The restlessness exhibited by the patient during the first nine post-operative days may have been due to his excessive thirst at a time when he was still unable to communicate his wants in a rational manner. The persistence of the diabetes insipidus is evidence of the destructive nature of the lesion which must have occurred in the region of the tuber; it was probably caused by a brisk backward displacement of the sella turcica at the moment of injury. The transient cerebrospinal rhinorrhœa may have come from the basal portion of the dural tear where the graft was not satisfactorily sutured; the bilateral anosmia and the extensive fracture of the anterior fossa found at operation make it likely that the cribriform plate was broken and allowed the passage of cerebrospinal fluid.

Case 2.—**Compound fracture of frontal sinuses, fracture of ethmoidal sinuses. Laceration of dura. Operation. Extradural abscess following streptococcal throat infection fourteen days after the accident.**

HISTORY.—T. W., aged 19. This patient was admitted to the Manchester Royal Infirmary under the care of Mr. Buckley on Jan. 28, 1941. He had been struck on the forehead by a brick which had fallen from a height of 30 to 40 ft.

ON EXAMINATION.—Two hours later he answered all questions rationally but slowly, and he had been incontinent of urine. In the middle of the forehead there was a semilunar laceration about 3½ in. in length (*Fig.* 192, A). Beneath this wound a comminuted depressed fracture of the frontal bone could be palpated. He bled from the left nostril, and his left eye

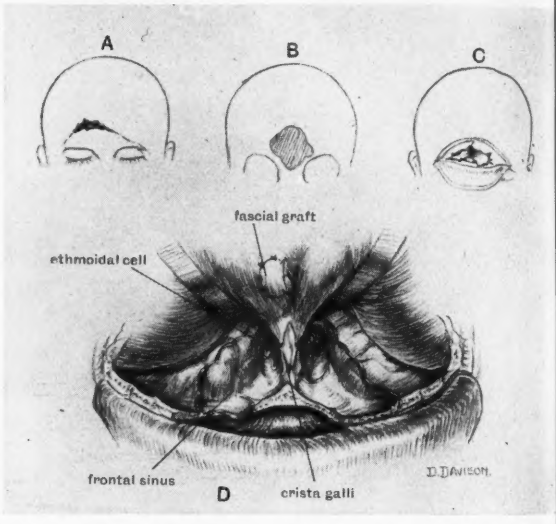

FIG. 192.—*Case* 2. A, Skin laceration; B, Diagram of post-operative radiograph; C, Skin-flap reflected; D, Frontal lobes retracted to show floor of frontal sinuses and opened ethmoidal cells.

was closed by a large orbital hæmatoma. Radiographs were taken and showed that both frontal sinuses were involved in the fracture.

AT OPERATION.—Five hours after the injury he was operated on. The depressed fragments of both walls of the frontal sinuses were removed. In the anterior fossa the fracture was seen to extend into the roofs of the ethmoidal cells; they were opened and curetted. The roof of the orbit was not involved in the fracture on either side. Just to the left of the longitudinal sinus there was a 1-in. slit in the dura and the underlying brain was bruised, but the pia was intact. A periosteal graft, freshly exposed by prolonging the skin incision, was used to repair the dural tear. Arachnoidal granulations on either side of the longitudinal sinus bled briskly, but they yielded to electrocoagulation. Other details of the operation, removal of the mucous membrane of the paranasal sinuses, the levelling-off of overhanging bone edges, closure and drainage, were similar to those employed in the preceding case. (*Fig.* 192, C, D.)

POST-OPERATIVE PROGRESS.—The wound healed cleanly, leaving a linear scar. His general condition remained good and he was mentally lucid. On the fourteenth day, when he was to be discharged to a convalescent home, he complained of a sore throat, his temperature rose to 102°, and his fauces were inflamed. For the first time he complained of a frontal headache and two days later the skin over the

bone defect was red and swollen. A day later the swelling fluctuated and 20 c.c. of pus were evacuated through a small skin incision and the resulting cavity drained. Hæmolytic streptococci were cultured, both from the throat and from the pus. The cavity was allowed to fill with granulation tissue, a process which took over two months. Since then he has been free from complaints and he returned to his former employment four months after the injury. In September, 1942, the skull defect was covered with an outer table graft.

FIG. 193.—*Case* 2. Photographs of patient before and after bone-grafting.

Comment.—The interesting feature in this case was that in spite of a heavy infection of the space between dura and skin secondary to an infected throat, the patched dura prevented the infection from invading the meninges. The abscess delayed recovery, but the patient's general health remained good and he could be discharged from hospital to attend for dressings as an out-patient. For fear of lighting up a dormant infection, the insertion of a bone-graft was deferred for over a year. *Fig.* 193 shows the appearance before and after the grafting operation.

Case 3.—**Compound fracture of right frontal sinus, right ethmoidal cells, right orbital roof, and lateral wall of right orbit. Traumatic blindness of right eye and anæsthesia of right cornea.**

HISTORY.—P. W., aged 35, a soldier, was admitted to the Salford Royal Hospital under Mr. Garnett Wright on June 28, 1941. He was seen by the writer about four hours after he had been injured. He had fallen off a lorry which was travelling at about 30 m.p.h. and had struck the right side of his forehead against a traffic island.

ON EXAMINATION.—He was restless, resented examination, but gave his name, address, and the name of his regiment correctly. The right pupil was dilated and reacted only to indirect illumination; the left pupil was of average size and reacted normally. External ocular movements were full in all directions. The right corneal reflex was absent. He moved his legs and arms with normal strength, but both plantar responses were extensor. There were two skin lacerations above the right eyebrow, and X rays revealed an extensive fracture of the right frontal sinus, the roof of the right orbit, the external angular process, and the lateral wall of the orbit on the right side.

AT OPERATION.—The skin lacerations were excised, joined, and a horizontal incision across the midline was added to give better exposure (*Fig.* 194, A). Skin-flaps were then raised to expose all the fractured bone, which included the lateral part of the supra-orbital ridge, both walls of the right frontal sinus, and the anterolateral third of the orbital roof (*Fig.* 194, C). A fracture line extended backwards in the roof of the orbit towards the optic foramen. The lateral wall and lateral half of the roof of the orbit had been detached by the trauma from their bony connexions and were held in place only by temporal muscle and dura. The bone removal included the greater part of the right frontal sinus, leaving only the medial part of its floor and its septum. A small

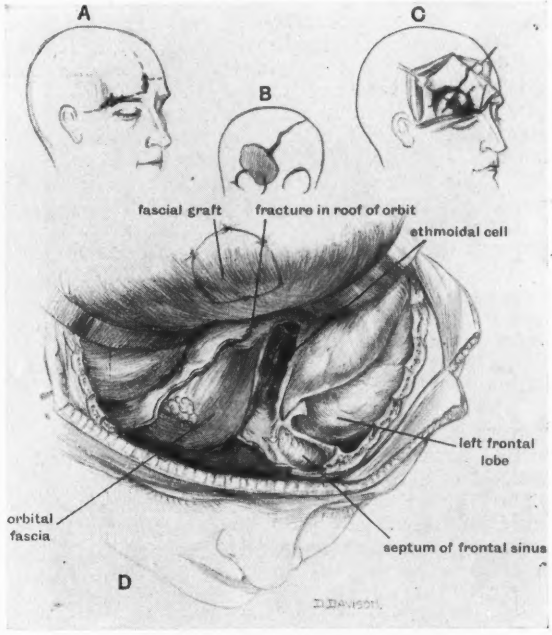

FIG. 194.—*Case* 3. A, Skin laceration—interrupted line indicates extension of incision; B, Post-operative radiograph; C, Fractured bone exposed after reflection of skin-flaps; D, Operative field prior to closure of skin.

perforation in the septum was closed by a muscle-graft and bone wax. The right ethmoidal cells had been widely opened by the fracture. Pulped brain extruded through a laceration of the basal dura; the orbital convolutions and sub-cortex of the right frontal lobe were removed by suction, leaving a clean cavity about the size of a hen's egg (*Fig.* 194, D). The dural tear was grafted, the wound closed, and a drain left in for forty-eight hours.

POST-OPERATIVE PROGRESS.—Healing was uneventful. The right eye remained blind and the cornea insensitive, but no wider trigeminal anæsthesia was observed. A corneal ulcer developed in the second week and was treated by tarsorrhaphy. He returned to his former civilian employment about five months after the injury, but he still complains of lassitude and occasional headaches. He has no anosmia.

Comment.—This patient received the force of the blow on the lateral part of the forehead and the sinus injury was unilateral. Fissured fractures radiated from the depressed, fragmented bone into the vault and into the base, and a portion of the orbital wall had become detached. The optic nerve was probably crushed at the optic foramen and primary optic atrophy was fully established a fortnight after the injury. Anæsthesia of the cornea without anæsthesia of the forehead is not a common finding; it must have been caused by intra-orbital division of the ciliary branches of the nasal nerve. The patient refused a reparative graft, although his deformity is a severe one.

Case 4.—**Compound fracture of both frontal sinuses, fracture of orbital roofs and ethmoidal cells, extensive laceration of right frontal lobe.**

HISTORY.—G. G., aged 19, a member of the R.A.F., was flung off his motor-cycle when he collided with a pedal cyclist. He was admitted to the Altrincham General Hospital at 7.30 p.m. on Dec. 10, 1941, under the care of Dr. Langdon, and was first seen by the author shortly after midnight. He had bled from both nostrils and had vomited blood.

ON EXAMINATION.—Over the left side of the forehead there was a slanting skin laceration about 1 in. in length, and through this pulped brain oozed whenever the man strained. Both eyes were closed by hæmatomata. He made verbal response when spoken to, but did not answer rationally. No other neurological disability was observed.

The X-ray films showed a deeply depressed fracture of the frontal squama, the depressed portion having the shape of three-quarters of a circle, with a straight lower border which ran slightly above the supraciliary arches. The depressed fragment was divided into two equal halves by a vertical fracture line which continued upwards into the vault.

AT OPERATION.—It was thought that the main brain damage would be on the left side and a left fronto-temporal skin-flap was raised and a straight incision along the right eyebrow added to give full exposure of the damaged bone. The lower two-thirds of the depressed bone were nibbled away, exposing fragmented portions of the posterior wall of the frontal sinus resting on the dura. The upper third of the depression was elevated and left in situ. The ethmoidal cells and the orbital roofs were found splintered on both sides. Contrary to expectation, the main cerebral damage was to the right frontal lobe, and when all the pulped brain had been removed, the vertical part of the falx was exposed medially in its whole extent and the right olfactory bulb and about ½ cm. of the olfactory tract uncovered. Perfect hæmostasis was secured, the dural tear sutured, and a temporal fascial graft, 3 in. by 1 in., stitched over it. In exploring the dura and its attachment to the left cribriform plate, a small tear was accidentally produced and covered with a muscle-graft. The wound was closed in two layers and drained for twenty-four hours. The patient was very restless and required a total of 75 c.c. of evipan during the operation, which lasted three hours. The anæsthetic was injected in 2-c.c. to 3-c.c. doses into the rubber tube of the intravenous drip.

The local healing of the wound and the general recovery of the patient were entirely satisfactory. Six weeks later the bone defect was covered with an ilium graft.

Comment.—This patient had suffered very extensive damage to his right frontal lobe and more than half of the total operating time was spent in dealing with the cerebral laceration and in controlling hæmorrhage from veins torn off short at their entrance into the longitudinal sinus. The 'traumatic lobectomy' has had no detrimental effect on his emotional or intellectual state, and he has returned to the R.A.F. to do light duty.

Case 5.—**Compound fracture of both frontal sinuses and both supra-orbital ridges. Laceration of dura.**

HISTORY.—R. N., aged 21, a sergeant-pilot, was first seen at an E.M.S. hospital forty-eight hours after he had crashed his 'plane into a tree when making a forced landing. He remembered all details leading up to the accident, but had no recollection of the impact. He was rational and had no neurological disability.

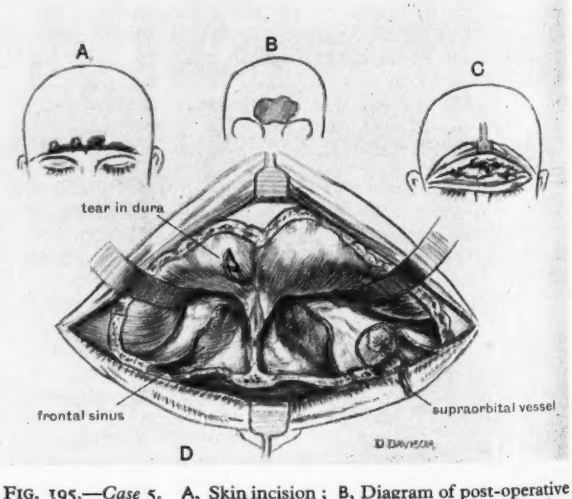

FIG. 195.—*Case* 5. A, Skin incision; B, Diagram of post-operative radiograph; C, Fracture exposed; D, Drawing of operative field after removal of fractured bone. Note that a portion of the left supra-orbital ridge has been removed.

ON EXAMINATION.—A skin laceration about 5 in. in length ran parallel with the supra-orbital arches, and the X-ray films showed a depressed fracture of the frontal squama, involving both walls of the right and left frontal sinuses.

AT OPERATION.—The comminuted bone fragments and the mucous membrane of the sinus were removed and all overhanging edges levelled off. The

left supra-orbital arch had been broken lateral to the frontal sinus and a portion of the arch had been detached by the injury, exposing orbital fat and the supra-orbital vessels. A small dural tear to the right of the longitudinal sinus was sutured and patched with a pericranial graft. There was no visible brain damage. The ethmoidal cells were not involved in the fracture. The wound was drained for twenty-four hours and healed by primary union.

FIG. 196.—*Case* 5. Photograph of patient after closure of wound.

Eight weeks later the bone defect was grafted with an outer table graft and the cosmetic result was satisfactory. (*Figs.* 195, 196.)

Comment.—The time that elapsed between injury and operation was longer in this than in the preceding cases. Infection was particularly to be feared, not only on this account, but also because the patient's skin contained many acne pustules. The presence of the skin infection made me doubt the wisdom of performing a graft operation, but the patient, anxious to return to flying, was determined to have the bone defect covered and all went well. He has returned to the R.A.F. and is back on flying duty.

Case 6.—**Compound depressed fracture of left frontal bone, left supra-orbital ridge, left roof of orbit, laceration of dura, laceration of left frontal pole.**

HISTORY.—J. S. B., aged 2½, was run down by a lorry and was first seen by the author in Withington Hospital three hours after the accident.

ON EXAMINATION.—His general condition then was grave; his pulse-rate was uncountable, and his respirations 26 per minute and shallow. He was pale and had lost a good deal of blood from a wound on the left side of the forehead and pulped brain lay on the skin around the laceration. Operation was deferred for three hours and in the meantime he was given a blood transfusion. He was still unresponsive when brought to the operating theatre, and hardly flinched while the local anæsthetic was injected. His general condition then, though a little better, was by no means satisfactory.

AT OPERATION.—Two triangular portions of the frontal squama with their base at the supra-orbital ridge, were found to have been angled backwards and a portion of the orbital roof, in continuation with this fracture, was splintered. Over the whole extent of the fracture the dura was torn, both along the base and over the convexity. A wedge-shaped area of the frontal lobe was pulped and was sucked away, leaving a clean cavity in the brain. The dura could then be easily approximated by overlapping sutures. The wound had been very dirty and contained soil and a fragment of cloth from the child's cap. It was drained for thirty-six hours and healed by first intention, with the exception of a small area which granulated under a scab.

POST-OPERATIVE PROGRESS.—For three days after the injury the child remained difficult to rouse, later it became restless and irritable, but finally recovered completely. When last seen a year after the accident, the child appeared normal in every respect and the parents had observed no abnormality in its behaviour.

Group II. Two Cases of Compound Fronto-orbital Fracture treated by Superficial Débridement

Case 7.—**Compound fracture of both frontal sinuses and roofs of orbits. Wound excision, removal of superficial bone fragments ten days after the injury.**

HISTORY.—L. A., aged 26, was admitted to the Manchester Royal Infirmary under the care of Professor Jefferson on April 4, 1942. Ten days before his admission he had crashed on his motor-cycle into a stationary cart and horse. He was taken to a nearby hospital, where he arrived unconscious and was found to have a triradiate skin laceration which occupied the middle two-thirds of the forehead. The wound was dressed, but not sutured. Three days later the patient regained consciousness sufficiently to recognize his relatives. About a week after the accident his temperature rose to 102°, he became more drowsy, his neck was stiff, he had bilateral Kernig's sign, and meningitis was diagnosed.

FIG. 197.—*Case* 7. Radiograph showing the extent of the fractures.

ON ADMISSION.—He was restless, resented interference, and was disorientated for time and space. Both eyes were closed by œdema of the eyelids, his neck was stiff, and he had bilateral extensor plantar responses and positive Kernig's signs. Radiographs of the skull showed that both frontal sinuses and the roofs of both orbits were broken (*Figs.* 197, 198, A).

The wound edges looked unhealthy, the neighbouring skin was red and œdematous.

AT OPERATION.—Under evipan anæsthesia the wound was excised and a fragment of bone about 1½ in. by 1 in. which was not attached to the pericranium was removed. This fragment consisted of

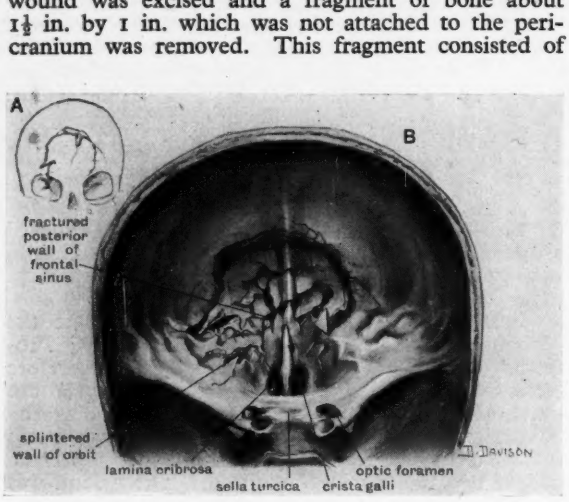

FIG. 198.—*Case* 7. A, Diagram of X-ray appearances; B, Coronal section of skull. Presumable extent of bony injury in anterior fossa reconstructed from the radiograph.

anterior wall of the frontal sinus, and smaller bone splinters from the posterior wall of the sinus were picked out of the wound. A small quantity of thin pus escaped. The wound edges were approximated with sutures and two large drainage tubes brought out through the wound and removed on the second day. The signs of meningeal irritation cleared up, but he remained restless and was not amenable to reason. At times he was incontinent. Two weeks later his temperature rose to 103°, he had bilateral abducent weakness, a right lower facial weakness, the right grip was weaker than the left, and the right plantar response was extensor. The wound was reopened, some extradural pus was evacuated from the left side, and two necrotic pieces of bone removed. The wound was packed with flavine and paraffin. Cerebrospinal fluid obtained by lumbar puncture on the same day contained 54 lymphocytes per c.mm., proteins were 150 mg. per 100 c.c., and the globulin content was raised.

POST-OPERATIVE PROGRESS.—For the next four weeks his temperature fluctuated between 99° and 100° and his state of consciousness slowly began to improve. He complained of a great deal of pain in his left leg in the distribution and along the course of the sciatic nerve; the left ankle-jerk was absent and there was some wasting of the calf muscles. He had bilateral anosmia. When, nine weeks after admission, he was transferred to another hospital, he was still too ill to get up, but the wound had filled in by granulation and his temperature had been normal for some days.

Comment.—The bony injury in this case was as extensive as in any of the cases in the first group. Almost certainly the ethmoidal cells were involved in the fracture, but this could not definitely be demonstrated on the X-ray films. The injury to dura and brain may be surmised from the operative experience in the other patients and the complications which attended the recovery in this case (*Fig.* 198, B). There must have been a tear in the dura and probably he had suffered extensive brain damage, for he remained mentally confused for about five weeks following the accident. Presumably one or both frontal lobes were bruised and lacerated; the brain debris became infected and gave rise to an encephalitis and meningeal reaction. No organisms could be cultured from the wound or from the cerebrospinal fluid at any time. This and the fact that he finally recovered is proof that the infection was a low-grade one. The sciatic pain was probably due to a neuritis of the nerve caused by a metastatic spread of the infection.

He has now a large and unsightly scar in the forehead and the deformity will be difficult to correct. In view of the past infection it will be a long time before one dare entertain the idea of repairing the scar and bone defect.

Case 8.—**Compound fracture of both frontal sinuses, fracture of roof of left orbit.**

HISTORY.—H. J. G., aged 31. On Jan. 6, 1942, this man crashed into the rear of a lorry when riding his motor-cycle. He wore no crash helmet at the time of the accident. He had a cut along the left supraciliary arch which was sutured, but the underlying bone was not explored. He remained unconscious for about nine days following the accident. About a fortnight later the patient and nursing staff noticed that he had cerebrospinal fluid rhinorrhœa, but the surgeon-in-charge was not informed. One month after the injury he became comatose, his temperature rose to 103°, and he had neck rigidity and positive Kernig's signs. The cerebrospinal fluid was turbid and contained many thousand polymorphonuclear leucocytes. He remained unconscious and incontinent for about a fortnight and then gradually began to improve with M & B therapy. After his recovery from this attack of meningitis he complained of dizziness, headache, and pain and numbness in the left leg.

ON EXAMINATION (five months after the patient's accident).—It was found that his sense of smell was unaffected; he had a left facial paresis and decreased hearing in the right ear. The left calf and thigh were tender to pressure and the skin on the outer border of the left foot was hypo-æsthetic to pin-prick and cotton-wool. Otherwise there were no abnormal neurological signs. Radiographs of the skull showed that a segment of the left supra-orbital ridge which contained frontal sinus was broken off; there was a curved fracture with an upper convexity on the left side of the forehead which skirted the upper border of the left frontal sinus and extended downwards into the posterior wall of the right frontal sinus. From the highest point of the curved fracture a fissured fracture extended upwards into the left side of the vault.

Comment.—No detailed observations concerning this patient's convalescence were available. The X-ray appearances did not suggest that the ethmoidal cells or lamina cribrosa were involved in the fracture, and the cerebrospinal fluid rhinorrhœa probably came through the frontal sinus. The dura must have been lacerated, but the extent of the brain injury must remain unknown. It is curious that this patient also showed signs of a sciatic neuritis.

ANATOMY AND MECHANISM OF THE INJURIES

The usual text-book presentations of the anatomical facts regarding the paranasal sinuses stress aspects most likely to be of use in an exploration of the cavities through the nose. Their exposure in the anterior fossa is an unfamiliar anatomical exercise.

The extent to which the anterior fossa may be pneumatized varies within wide limits, not only from case to case, but the right and left halves may present striking differences. One or both frontal sinuses may be absent or the entire roof of the orbit contain an extension of the frontal or frontal and ethmoidal sinuses. These air cavities in their development so compete with each other that where the one lags behind the other invades the bone, and no constant rule can be laid down regarding their relationships. Commonly the frontal sinus overlaps ethmoidal cells posteriorly (*Fig.* 199, C), so that its floor forms the roof of a varying number of anterior ethmoidal cells. The reverse condition—anterior ethmoidal cells lying above the caudal end of the frontal sinus—may be encountered, and not uncommonly an ethmoidal cell bulges into the posterior wall of the frontal sinus. In operating on the sinuses from above, the distinction between the posterior parts of the frontal and ethmoidal cavities is difficult to establish, particularly when comminuted fractures have opened both.

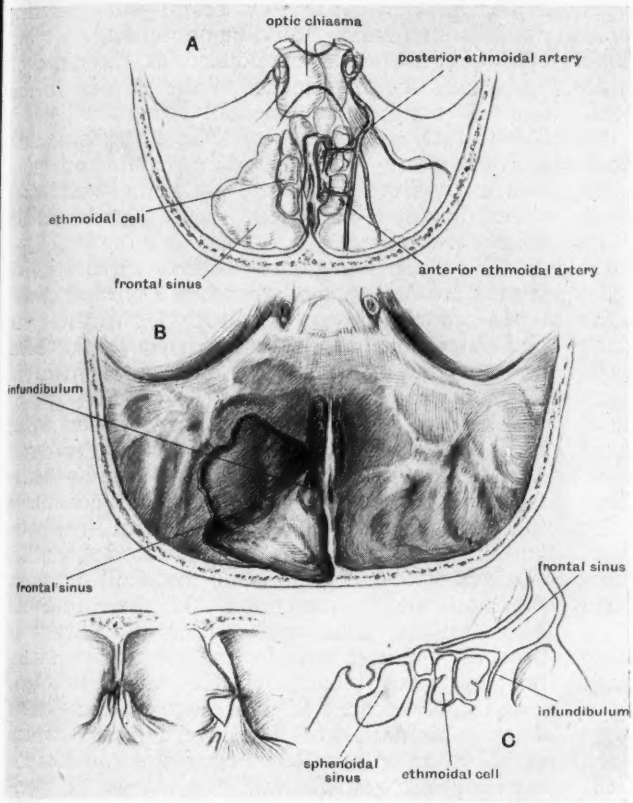

FIG. 199.—A, Diagrammatic projection of paranasal sinuses on to floor of anterior fossa; B, Drawing of anatomical dissection to show extent of frontal sinus after removal of its roof; C, Parasagittal section through paranasal sinuses showing ethmoidal cells under floor of frontal sinus.

The triangular floor of each anterior fossa consists of brittle, lamellar bone strengthened at its boundaries by a framework of firm bony struts. Posterolaterally a buttress connects the external angular process with the anterior clinoid process; anteriorly the strong supraciliary arch, well suited to its exposed position, connects the external angular process to the glabella. A line joining frontal crest, foramen cæcum, crista galli, and jugum sphenoidale, forms the internal boundary. A force which impinges on the supra-orbital arches will, if severe enough, communicate itself to the floor of the anterior fossa and tend to shorten the orbital plate in an anteroposterior direction. Should its elasticity be exceeded, the bone of the anterior fossa will bend upwards and break, following its natural curvature. This type of injury, an indirect bending fracture of the anterior fossa, may also be produced by a force applied to the external angular process and acting from the side (*Case* 3). A different mechanism underlies the occurrence of fissured fractures, which may run either in an anteroposterior direction or traverse the orbital plate from side to side. They are basal bursting fractures, the result of forces striking the vault of the skull above the level of the base; their direction depends on the direction of the injury and force and not uncommonly they may traverse the lamina cribrosa. A third mechanism may act in conjunction with the two that have been mentioned; the depressed anterior wall of the frontal sinus by impinging on the brittle posterior wall may break it over a wide area, including a portion of the anterior fossa.

Two types of fronto-orbital fracture were seen in the cases of the present series. In one the fragments were multiple, irregular, and wedged. In the other, of which *Case* 4 and *Case* 7 are examples, the depressed fragment was large and had the shape of a segment of a circle. The factors that determine the shape of the fracture must here as elsewhere in the skull include the size of the object that inflicts the damage and the force with which the skull is struck. The extent to which the frontal bone is pneumatized must also be an important mechanical determinant.

TECHNICAL CONSIDERATIONS

The operative principles may be briefly summarized. Before undertaking the operation good X-ray films should be available and give information whether the skin laceration alone will give sufficient exposure, if necessary with a small prolongation, or whether a skin-flap should be turned. If it is decided to turn a skin-flap independent of the wound, it is probably best to use a coronal incision and not to turn a unilateral frontal flap, for not only does the coronal incision give easy access to the whole forehead and both frontal lobes, but a transverse incision will be required when the bone defect comes to be

grafted. In dealing with the depressed bone the aim is not to elevate depressed fragments but to remove firstly the fractured anterior wall of the sinus. Caution should be exercised when the supraciliary arch is involved in the fracture, and only fragments that have been so detached from periosteum that they are not considered viable should be removed. If, after removal of the anterior sinus wall, a larger opening is required, bone may be nibbled away in an upward and lateral direction. By elevating the frontal lobe on each side with an illuminated retractor the floor of the anterior fossa should next be inspected. It has been the writer's practice to remove the roof of the horizontal portion of the frontal sinus so as not to leave any overhanging edges and to prevent the formation of dead space by allowing the dura to fall on to the floor of the sinus. In 4 cases of the present series comminuted fractures extended into the roof of the ethmoidal cells. Removal of the bone fragments laid the ethmoidal sinuses open and their mucous membrane was removed by twisting it out with artery forceps and by curetting with a sharp spoon. Arguments may be raised against this latter procedure, and the writer confesses that he is not convinced whether it is really necessary to attempt to remove as much mucous membrane as possible; it is certain that one can never remove it all, equally that its removal does no harm. The wisdom of enlarging the communication between intracranial and nasal cavities by using a sharp spoon on the ethmoidal cells is doubtful.

The ethmoidal vessels usually give rise to smart bleeding; they run from the orbit towards the cribriform plate and before entering the extradural space they are contained in grooves on the under-surface of the orbital plate. In order that their bleeding may be controlled, it is at times necessary to nibble away the roof of the bony canal in which they lie; for this pointed bone forceps are requisite.

Inspection of the dura for the presence of dural tears must include a gentle exploration of the dural attachment to the sides of the cribriform plate, bearing in mind the ease with which the membrane may be lacerated in this region by any attempt to detach it from the bone. If a tear is found it probably indicates that the cribriform plate has been fractured. It has already been said that this condition is more likely to be present in a bursting fracture of the base; it was not encountered in any of the cases in the present series. If it is suspected that the cribriform plate has been fractured it should be explored intradurally and the opening into the nose covered with a muscle-graft. The edges of dural tears elsewhere should be approximated and a free fascial graft sutured over them. Small lacerations may be satisfactorily covered with a piece of pericranium, but no graft should be taken from an area exposed by the skin laceration. Only in one of the cases in the first group did an abscess form at the site of operation; it was certainly secondary to a throat infection and not to the presence of the fascial graft which survived.

In all cases the skin was closed in two layers and a drainage tube brought out through the wound. It is unnecessary to drain the subdural space if no brain debris has been left behind and if all bleeding has been controlled. After removal of the drain on the first or second post-operative day its site of entry should be obliterated by tying one or two sutures introduced at the time of operation. Perfect closure of the skin is, in the author's opinion, an essential safeguard against the formation of sinuses. Nasal drainage has not been used. Sulphapyridine or sulphanilamide powder was sprinkled into all wounds and oral chemotherapy employed as a prophylactic measure.

The disfigurement that follows these injuries is considerable, particularly when a portion of the supra-orbital arch has been included in the bone removal. Four of the cases have so far been grafted. P. W. (*Case* 3), a married man, is satisfied with his appearance. J. S. B. (*Case* 6) will have to undergo a cosmetic operation when he is older. Two grafts taken from the outer skull table (*Cases* 1 and 5) were entirely satisfactory, but the ilium graft has the advantage that a larger area can be covered with firm bone and the operating time is much reduced if another surgeon takes the graft while the skull defect is prepared for its reception. If there are no complications, four weeks after the injury is probably the best time for the second operation, but this interval had to be prolonged in *Cases* 4 and 5, on account of acne pustules, and *Case* 1 delayed his decision. The local infection which had been present in *Case* 2 caused us to defer the insertion of a graft for well over a year. Experience has shown that there is no need to defer the bone-grafting in an uncomplicated case for several months. Such a wait is surgically unnecessary and economically wasteful. Synthetic plastic materials may come into use in place of bone.

SUMMARY

1. Eight cases of compound fronto-orbital injury are recorded.

2. In a group of 6 cases in which early and radical wound débridement was carried out the results were entirely satisfactory.

3. Two patients whose wounds had received only superficial attention passed through a long period of convalescence attended by intracranial infection.

4. The anatomy and mechanism of the injuries is discussed.

5. Some technical points are emphasized.

My thanks are due to Professor Jefferson both for his advice concerning the operative treatment of the cases and for his help in the preparation of this paper.

RECURRENT HERNIA

AN INVESTIGATION OF THE CAUSES OF RECURRENCE AND THE APPLICATION OF THE PRINCIPLES OF TREATMENT OF THE PRIMARY LESION

By WILLIAM PATRICK, T/Lieut.-Colonel, R.A.M.C. (T.A.)

OFFICER-IN-CHARGE SURGICAL DIVISION, GENERAL HOSPITAL, C.M.F.
ASSISTANT SURGEON, ROYAL INFIRMARY, GLASGOW

The number of cases of recurrent hernia is too high. Surgeons on the staffs of military, E.M.S., and civilian hospitals might equally be held responsible, but it would be imprudent to attach the blame to any one particular group without a considerable amount of investigation. The subject of recurrent hernia is one of great importance and surgical text-books deal inadequately with this too frequent condition and with the causes of recurrence. All phases of the treatment of the primary lesion require careful reconsideration in order to establish a more reliable technique, and also for the purpose of instructing the inexperienced surgeon. There must always be a recurrence rate, unfortunately, but there would appear to be no doubt that post-operative recurrence of hernia is increasing, and on that account this investigation has been considered to be worthy of record. The whole management of the primary lesion can be conducted in a much more satisfactory manner if the causes of recurrence are fully understood.

The object of this paper is to investigate all possible factors relating to the recurrence of the hernia in a series of cases treated and to elaborate in detail the principles of the treatment of the primary condition in the light of the information so obtained.

The cases were accumulated in the spring of 1942, but service overseas prevented any investigation of the facts for some considerable time thereafter.

INVESTIGATION

The definition of a recurrent hernia has been taken to be a herniation occurring beneath the scar of a previous operation, irrespective of the interval of time between the primary operation and the recurrence.

GENERAL INVESTIGATION

During the period from December, 1940, to the end of the second week in May, 1942, just over eighteen months, 77 cases of recurrent hernia came to operation at a military hospital in England. One other military hospital was located in the same Command. Of these 77 cases I personally operated on 70 cases, and this investigation will be concerned with personal cases only. It should be mentioned that for approximately the first twelve months of this eighteen-month period recurrent hernias were being dealt with in all types of hospitals—that is, military, E.M.S., and in some cases civilian—and it was only in the later months of the period that cases of recurrent hernia were concentrated entirely in the two military hospitals of the Command. Unfortunately no figures are available for the number of recurrent cases seen as out-patients or for the number of recurrences not treated by operation. All cases were of the inguinal variety. Recurrences on the right side were practically twice as many as those on the left; this might indicate

Author :—	*Cases*	*Other surgeons* :—	*Cases*
Right side	46	Right side	3
Left side	24	Left side	3
	70		7

that more primary operations were being carried out on the right side than on the left. Can one deduce from this that the right side is more liable to a hernia? I know of no anatomical feature, peculiar to the right side, which would render it so liable, but the majority of workers, being right-handed, take any strain on that side; it may be, then, that a sudden or a repeated trauma to the preformed sac accounts for the apparent frequency of right inguinal hernia.

Of the 70 personal cases, rather more than half of the primary operations had been performed in military hospitals. With only two exceptions,

Operations in Military Hospitals :—	*Cases*	*Operations in Non-Military Hospitals* :—	*Cases*
Right side	28	Right side	18
Left side	11	Left side	13
	39		31

all 'military' operations had been performed since the outbreak of war (the two exceptions being cases of Regular Army personnel, one operated on in an Air Force hospital in Britain in 1932 and the other in Hong Kong in 1934). This indicates an early recurrence and the possible reason for this will be investigated later. On the other hand, the 'non-military' cases ranged over a much wider period, there being only 8 in this group which had been operated on primarily since the outbreak of war. It is not one of the objects of this paper to prove or disprove that 'military' surgery has been largely responsible for a high recurrence since the outbreak of war,

but these comparative figures require some surgical explanation.

DETAILED INVESTIGATION

The detailed investigation of these 70 cases was made as exhaustive as circumstances permitted; it was not possible for many reasons, however, to obtain any information regarding the original operation, except in the case of one recurrent hernia of my own which came back under my care. The probable factors likely to cause recurrence were investigated and these are enumerated below.

In every case except 11 (shown in the last two age-groups—*see Table II*), the type of patient may be excluded as a possible causative factor in the recurrence, as all were healthy muscular individuals living under military service conditions.

1. The Nature of the Recurrence.—

a. The Repair of the Canal.—At an operation for recurrent hernia one finds very frequently that the detail of the original operation cannot be determined unless some outstanding method of dealing with the canal has taken place; this ignores the question of the sac, as it is assumed that the sac should be dealt with adequately at any operation for a primary hernia irrespective of the so-called 'repair' of the canal.

At the subsequent operation it was only possible to state that, out of 70 cases, the primary operation had been performed in accordance with a definite procedure in 11 cases. One case showed that the cord had been placed in front of the external oblique aponeurosis (operation at the age of 8 years in 1931). The Bassini operation was responsible for 10 recurrences (6 on the right side and 4 on the left), and 1 of these included at the same time a repair by a Gallie fascial graft; 4 of these Bassini operations had been performed in civilian life and the remaining 6 by military surgeons.

The case with the Bassini repair and fascial graft is worth recording:—

The patient was a man of 31 years with over eight years' regular service in a field regiment. The original operation had been done on Sept. 3, 1941, in a military hospital and he had remained in bed for 27 days thereafter; then followed 16 days at a B.R.C.S. convalescent home and 3 weeks at a convalescent depot; for the next 2 weeks he remained at a holding depot on 'light duty'; this was followed by 2 weeks' sick leave. He then rejoined his unit—that is, 13 weeks after operation. Three weeks after rejoining his unit the swelling recurred—4 months after operation—without any known contributory cause.

At operation on April 9, 1942, the scar on the lateral side of the right thigh was soundly healed without herniation. There was a swelling at the medial side of the right inguinal canal about the size of a golf-ball. A dense fibrous reaction had occurred; on the under surface of the external oblique a small black piece of ligature material was found. A thin-walled, funnel-shaped sac, of a dense texture, with the usual adventitious layers, was found projecting forward through a definite gap in the posterior wall of the canal inferior to a high border of the conjoined tendon.

The sac of the hernia was obviously a new one. The lateral portion of the canal was very firm and intact; there was no visible evidence of the fascial repair from the original operation 6 months previously.

These figures for the Bassini operation are surprisingly low—roughly 14 per cent of 70 cases, but this type of operation has been found by other investigators to form a much higher proportion of primary operations—in one group 60 per cent of 127 cases. The posterior wall of the canal is thought to be strengthened by the Bassini operation, which it may well be, but the tissues at the medial side of the canal often give way or become thinned out, thus leaving that part of the canal in a weak and unprotected state, predisposing to the formation of a direct hernia; of the 10 'Bassini recurrences' 4 were of the direct type. The other disadvantage of this operation is that the gap at the exit of the cord from the muscular layer cannot be completely closed and by its very nature predisposes to an oblique recurrence. The remaining 6 cases in this group were all oblique recurrences, but in fairness to the Bassini operation it should be stated that in 5 of these the primary sac had not been removed. The only other feature of interest with regard to these recurrences following the Bassini operation is the age-group factor in relation to the time-interval factor of the reappearance of the hernia (*see Table II*). No age-group was specially involved and the hernias had all recurred at varying intervals up to eight years after the original operation.

The detail of the original operation in the remaining 59 cases (39 of which occurred on the right side and 20 on the left side) could not be determined; it might be assumed, therefore, that no specific repair operation had been carried out and that the canal had been left unaltered or the so-called conjoined tendon simply brought down to Poupart's ligament. In many a considerable amount of matting and fibrosis to a varying degree had taken place, both superficial and deep to the external oblique aponeurosis; some adhesion of varying strength had also occurred between the muscular layer, and even the tendinous part of the conjoined tendon, and the deep surface of the inguinal ligament, contrary to the usually accepted teaching; the spermatic cord had often been involved in the general disturbance. This adhesion formation may only be of a temporary nature, however, as in 3 cases where the primary operation had taken place in infancy, 21 years, 28 years, and 30 years ago respectively, the muscular tissues were found to have been of poor tone, the lower edge of the conjoined tendon was highly arched, and the aponeurotic layers considerably thinned out. This fibrous matting can be attributed to local trauma and ordinary repair, but it may subsequently infiltrate muscle to the extent of interfering with the recovery of its tone.

b. The Sac.—The investigations of the sacs of the recurrent hernias produced much interesting information. 'Indirect' sacs were found in 52 cases and 'direct' sacs in 18 cases :—

Indirect :—	*Cases*	*Direct* :—	*Cases*
Right side	35	Right side	11
Left side	17	Left side	7
	52		18

Before coming into contact with such a concentration of recurrent hernias one had always been of the opinion that the anatomical type of sac found in a recurrent hernia was usually 'direct'; the disproportion of nearly 1 to 3 seems to suggest some very definite accounting factors, and a further analysis produced the information shown in *Table I*.

Table I.—Types of Sac and Related Causes of Recurrence

A.—Oblique Sacs

	Classification	*No. of Cases*	*Army Cases*	*Civilian Cases*
i	Sac not removed at previous operation	17	10	7
ii	Sac only tied at neck	9	5	4
iii	Sac incompletely removed	7	4	3
iv	New sac arising from previous neck	3	2	1
v	Apparently new sac	16	8	8
	Total	52	29	23

B.—Direct Sacs

	Classification	*No. of Cases*	*Army Cases*	*Civilian Cases*
i	Operation in infancy	3	—	3
ii	Second recurrence	3	1	2
iii	Bassini operation	4	3	1
iv	New sac without obvious cause	8	6	2
	Total	18	10	8

Oblique Sacs: It is not certain that all the original operations had been performed for oblique hernias, but it can reasonably be assumed that such was the case. In each causative group (*Table I, A*) the number of operations performed by civilian surgeons approximated that performed by military surgeons, and a study of the respective figures for each group will show that it is impossible to draw any conclusions therefrom.

i. *Sac not removed at operation*: It would appear incredible that in 17 cases out of 52 (practically 33 per cent) the sac had not been removed at the previous operation. In every case the sac found at re-operation was well-formed and rather thick-walled; there was a definite constricted 'neck'; the fundus was found well down in the canal, sometimes approaching the upper pole of the testis. The primary operation in the civilian cases had taken place just prior to the outbreak of war or at least a short time before 'call-up' with the individual age-group; the military cases had all been done since the outbreak of war. It can only be accepted, therefore, that the hernial sacs found at operation for recurrence had all been present at the time of the original operation, and one is forced to the conclusion that the surgery of the primary operations had been grossly incompetent.

ii. *Sac only tied at neck*, and

iii. *Sac incompletely removed*: These groups may conveniently be taken together. It was apparent anatomatically that 9 sacs had only been tied at the neck and that 7 had been incompletely removed. Some surgical treatment, therefore, in these 16 cases (just over 30 per cent of 52 cases) had been attempted, but obviously had been inadequate, the sac still remaining in whole or in part. It is less than sufficient to tie off the sac at the neck and leave it, just as it is to remove it incompletely. Already at this stage in the investigation 63 per cent of 52 cases of oblique recurrences can be laid at the door of the surgeon.

iv. *New sac arising from previous neck*: New sacs were found to have originated from the 'neck' of the previously removed sac on three occasions (only 6 per cent)—a small figure, but one which could be reduced further with care. This type of recurrence was deduced from the appearance of the new sac at operation; the sac was small and thin-walled; the fundus showed some thickening at its extreme tip, which would correspond to the neck of the original sac; the neck was invariably wider than one would have expected to find in a primary funicular sac; there was an internal attachment of omentum to the fundus in each case. No other possible cause of recurrence could be found at operation.

v. *Apparently new sac*: In the remaining 16 cases (just over 30 per cent of 52 cases) no reasonable explanation of the recurrence could be found either in evidence or at operation, and the recurrence can only be put down to the formation of a

new sac; it may be, however, that the explanation for this group lies in the weakness of the transversalis fascia at the deep ring and this will be referred to later.

Included in this group is the recurrent case of my own which came back under my care during the period; the clinical record of the case is of interest as full details of the primary operation are available. The case is given in some detail to illustrate that type of case where apparently adequate surgery and careful post-operative control had failed to obviate a recurrence.

The patient was a healthy muscular young man of 24 years, serving in a field battery. The hernia at the time of the primary operation (June 30, 1941) was of the right inguinal variety and had been present for 11 years.

At operation an adherent indirect biloculated sac was found and it was completely removed from above the 'neck'; the stump was oversewn and fixed to the abdominal muscles fully an inch above the deep ring; part of a rather bulky pampiniform plexus was excised and the musculo-tendinous layer approximated to the inguinal ligament in front of the cord; the aponeurotic layer was sutured and the wound closed in layers.

Sixteen days after operation he was transfererd as a bed patient to the convalescent home attached to the military hospital, where all post-operative hernia cases were sent, and where a controlled convalescence was in force under the supervision of a medical officer. He remained there for 3 weeks; he was then at a convalescent depot for 3 weeks, where graduated remedial exercises were given. He returned to his unit approximately 2 months after operation and he was given 'light duty' for 1 month.

In November, 1941, 2 months after returning to ordinary duty and 5 months after operation, the swelling recurred.

The only gap in the evidence is that of the month he was supposed to have been on light duty; it often happens in units that 'light duty' simply means fatigues which are in themselves heavier in some respects than ordinary duty and less of a remedial nature.

At the subsequent operation on May 4, 1942, a strong matting reaction was noted; an oblique sac was found, 3 in. long, rather thin-walled, and adherent to the remaining tissues of the cord.

One finds, therefore, that, excluding the cases in (i), (ii), and (iii), which have been shown to have been due to bad surgery, there were 19 cases which might be regarded as 'obscure' recurrences; this figure gives a more accurate proportion of 'indirect' to 'direct' than the figure of 3 to 1 previously assessed.

Direct Sacs: *Table I, B* shows that 18 recurrent hernias with a direct sac were found in 70 cases. The causes of a 'direct' recurrence are not so apparent as those of the indirect type, and the classification of these did not fall so easily into groups, but ultimately it was found that four possible methods could be selected for assessing the probable causes.

i. *Operation in infancy*: In this group there were 3 cases which had recurred after intervals of 21 years, 28 years, and 30 years; all primary operations had been performed in early infancy—at 6 weeks, 18 months, and a few months respectively. Obviously these are not true recurrences and should properly be regarded as primary direct hernias; in each case, however, the anatomical details of the sac and the inguinal region were identical with those found in the more recent types (*see below*) and in a general way the tissues were all of poor quality without evidence of fibrous reaction.

ii. *Second recurrence*: In this group there were 3 cases. The primary operations had taken place in 1933, 1936, and 1934, and the first recurrent operations in 1937, 1939, and 1941 respectively (*see also Table IV*). The second recurrence in the first case took place approximately 3 years after the second operation, and although the subject was a young man of 22 years, it is feasible that his army training in the Engineers may have been partly responsible, as the hernia became apparent one month after enlistment. In the second case there can be little doubt but that the operative technique at the recurrent operation was at fault, as the hernia recurred on his getting out of bed, 3 to 4 weeks after operation. In the third case there was probably a fault at operation also, as the hernia recurred just after he returned to ordinary duty, 4 months after operation.

iii. *Bassini operation*: With regard to this group, 3 of these operations performed by military surgeons recurred at 3 months, 4 months, and 4 months respectively, while the fourth, performed by a civilian surgeon, took 11 months to recur. It is reasonable to assume, I think, that the technique employed for the primary operation had some bearing on the recurrence in each case.

iv. *New sac without obvious cause*: In 8 cases in this group, that is, in just under 50 per cent of direct hernias and in just over 11 per cent of 70 recurrences, direct sacs were found where no obvious cause for the recurrence could be ascertained.

Several features common to all these direct hernias were noted. All sacs were thin-walled; each was somewhat difficult to find and was well covered by extraperitoneal fat and other adventitious layers; the neck was wide and with an ill-defined fundus made the whole sac more of an anterior 'bulge' through the posterior wall of the canal; sometimes a definite gap, large enough to admit the tip of a finger, with moderately firm edges, was found, and there was usually an elongated sac in this type; abdominal structures, chiefly bladder, were often in close proximity, and opening the sac required great care.

2. Age of Patient and Post-operative Time Factors.—

a. Age-group.—It was thought that some particular age-group might be more prone to recurrence than others and this was investigated irrespective of the side of the recurrence. The age for this grouping was taken as that at the time

of my personal operation. The age-group at the time at which recurrence took place was practically identical except in the last two time-interval periods and any difference does not affect the investigation.

Age-group	*Number of Cases*
Under 20 years	3
20–25 years	16
25–30 years	23
30–35 years	17
35–40 years	4
Over 40 years	7
	70

These figures do not throw any significant light on the question of recurrence, as the greatest incidence will be seen to have fallen on the age-group which, at the time when these cases were being treated, comprised the main bulk of service personnel over a 15-year period of optimum physical development and endurance.

b. Age-group in Relation to the Post-operative Time-interval before Recurrence.—Assessing the information which each individual was able to supply, it was possible to correlate the age-group with the post-operative time-interval when recurrence was noted; the results are detailed in *Table II.*

to be controllable; in addition, many of them should be preventable, and some of these have already been indicated in the case of faults in operative technique.

The recurrences during the second post-operative year are not so easily explained: in some it was found that the operation had also been at fault (sac); in others there was a definite change of work and manner of living—not that any such change in itself can be accepted as a single factor liable to produce a recurrence; in 2 cases the original operation had been a Bassini technique, which has been discussed already; in others there was no apparent reason for the recurrence. In general, therefore, nothing very material has resulted from this second-year group in spite of the increased number of cases occurring, but it does seem to be a period of some importance.

One curious feature, however, emerges from this age-group–time-interval comparison, and this is, that in spite of incompetent or inadequate surgery at the primary operation, many cases go for months and some for several years before the hernial swelling re-asserts itself clinically. Can it be assumed, in these cases, that the insult offered to the tissues at operation has produced

Table II.—AGE-GROUP IN RELATION TO TIME-INTERVAL BEFORE RECURRENCE

AGE-GROUP IN YEARS	UNDER 3 MTH.	3–6 MTH.	6–9 MTH.	9–12 MTH.	1–2 YR.	2–4 YR.	4–8 YR.	OVER 8 YR.	TOTAL
Under 20	–	1	–	1	–	–	–	1	3
20–25	2	5 (1)	2	1	3	1	1	1	16
25–30	3 (1)	6 (1)	1 (1)	1	8 (2)	1 (1)	1	2	23
30–35	3	2 (1)	4	2	2	1	3 (1)	–	17
35–40	–	1	3	–	–	–	–	–	4
Over 40	–	–	–	1 (1)	1	1	1	3	7
Total	8 (1)	15 (3)	10 (1)	6 (1)	14 (2)	4 (1)	6 (1)	7	70

The figure in brackets indicates a Bassini operation; e.g., 8 (1) means 8 operations, of which 1 was a Bassini.

The recurrence-rate under 3 months from the date of the previous operation was moderate (just over 11 per cent), but it rose to just over 21 per cent during the next three-monthly period; it fell again in the remaining two three-monthly periods, i.e., to the end of the first post-operative year, to just over 14 per cent and to 8 per cent respectively. There is a sharp rise, however, in the rate for the second year (20 per cent) and thereafter a decline.

It will be obvious, therefore, that the greatest incidence of recurrence took place up to the ninth month, with the period from three to six months especially vulnerable (just over 21 per cent of 70 cases) and during the second year after operation (20 per cent). These figures suggest that during the first nine post-operative months there may be some factors in the recurrence which can be associated either with the operative technique, the post-operative management of the case, or the duration of the period before the return to full duty. Many of these factors can be said a reaction sufficient to collapse the sac or at least to block its communication with the general peritoneal cavity in a temporary manner and that when these effects pass off any sudden or prolonged increase in the intra-abdominal pressure, with muscular strain, results in the clinical reappearance of the hernia?

3. Post-operative Treatment.—Under this heading should be included the post-operative management of the case, the convalescence, and the remedial therapy required to rehabilitate the man before he is considered fit.

In no instance, with the single exception of my own case, had there been any form of post-operative remedial therapy or any attempt to institute controlled muscular exercises in the cases investigated.

4. Interval before Return to Full Work.—The phrase 'return to full work' is always one of varied interpretation depending on the type of work and the man's differentiation between light duty and ordinary work; he has always some

difficulty, too, in remembering the exact interval between operation and his return to ordinary duty, and in most cases one has had to arrive at an estimate by computing the periods of time spent in the various stages of the post-operative period.

On these accounts, therefore, the detail of all 70 cases was considered to be insufficiently accurate; but 35 cases were taken, and the following table gives an approximate indication when these cases returned to ordinary work:—

Number of Cases	*Interval*
1	4 weeks
3	6 „
7	8 „
12	10 „
8	3 months
3	3 „
1	6 „

This is a brief and admittedly inadequate survey, nor does it take into account the nature of the work; on the whole, it would appear that the majority of the cases had been returning to work after the accepted interval and that a too-early return to duty had not been a pronounced factor in the causes of recurrence.

5. Other Factors influencing a Recurrence.—Included in the total of 70 cases were two groups, the investigation of which may produce a contributory factor in the recurrence of a hernia.

a. Unilateral Recurrence after a Bilateral Operation.—In this group there were 6 cases where a bilateral operation for a primary condition had been followed after varying intervals by an unilateral recurrence (*Table III*).

In 4 of these 6 cases the hernia reappeared within 7 months of the primary operation, and in the remaining 2 at 13 months and 19 months respectively; 4 recurred on the right side and 2 on the left. This unilateral recurrence following a bilateral primary operation raises the question of whether both sides should be operated on at the same time. It is difficult to be dogmatic on this point, but if one were to make a decision solely on the question of a probable recurrence, then one must, I think, decide against a bilateral operation unless in very exceptionally suitable cases.

b. Cases with Second Recurrences.—There were 5 cases in this group and the essential details of these are shown in *Table IV*. A curious feature found in this group was that only one of the operations had been performed in the Army. The duration of the second recurrence of the 5 cases was 1 month, 4 months, 3 years, 5 years, and 15 years respectively; the subsequent operative findings showed that 3 sacs were 'direct' and fairly well formed, and each had some internal attachment, and that 2 sacs were 'indirect', of the well-developed funicular type. It is only to be expected that the effects of repeated operations are likely to be definite factors in recurrence.

THE CAUSES OF RECURRENT HERNIA

It will be apparent from the preceding investigation that there are many causes of, and contributory factors to, recurrence.

Table III.—Bilateral Operations with Unilateral Recurrence (6 Cases)

Case No.	Date of Original Operation	Age at Original Operation	Period of Recurrence	Side of Recurrence	Operation In	Type of Original Operation
1	Nov., 1939	23 yr.	13 mth.	Right	Army	Bassini
2	Jan., 1941	21 yr.	7 mth.	Right	Army	Undetermined
3	March, 1941	29 yr.	7 mth.	Right	Army	Undetermined
4	1938	32 yr.	6 mth.	Left	Civil	Undetermined
5	April, 1941	32 yr.	2½ mth.	Right	Army	Undetermined
6	Feb., 1940	25 yr.	19 mth.	Left	Civil	Bassini

1. The chief cause of recurrence has been the incompetent or inefficient or inadequate treatment of the sac. After identification and isolation the sac must be radically excised and oversewn. No other treatment should be permitted and no surgeon should be allowed to perform an operation for hernia until he or she is fully aware of, and thoroughly conversant with, this fundamental step.

2. There are also factors associated with a faulty or ill-chosen repair of the canal. Such faulty operations should be discarded in favour of sounder methods, and special attention paid to the 'key' regions, which will be discussed later.

Table IV.—Cases with Second Recurrence (5 Cases)

Case No.	Year of First Operation	Year of Second Operation	Side of Recurrence	Duration of Second Recurrence	Type of Sac	Date of Third Operation	Age at Third Operation
1	1924 (C)	1926 (C)	Right	15 yr.	Indirect	Nov., 1941	20 yr.
2	1933 (C)	1937 (C)	Right	3 yr.	Direct	Dec., 1941	22 yr.
3	1936 (C)	1939 (C)	Left	1 mth.	Direct	Feb., 1942	30 yr.
4	1934 (C)	1941 (A)	Right	4 mth.	Direct	March, 1942	25 yr.
5	1914 (C)	1935 (C)	Right	5 yr.	Indirect	April, 1942	34 yr.

C, Civilian operation; A, Military operation.

3. Faulty post-operative management of the case can also be said to be a contributing factor. This may include the complete absence of remedial exercises, the lack of graduated physical training or hardening, and a badly controlled return to duty.

4. There is also the type of recurrence for which no adequate explanation is found at operation; in this connexion, it is thought that the reason may be a weakness of, and perhaps a definite gap in, the transversalis fascia at the deep ring, resulting from the previous operation. Measures for its reinforcement will be given later.

5. The proper selection of cases completes the investigated causes of recurrence; in this group are included these recurrences after a second and even a third operation, and there is also the possibility of a recurrence following a bilateral primary herniotomy.

6. Possible causes which have not been brought out by the investigation, but which must always be regarded as contributory factors, are: (*a*) Severe handling of the tissues and dislocation of the cord—this is thought to be likely to produce a recurrence of the 'direct' type; (*b*) Incomplete hæmostasis and sepsis in the wound; (*c*) Serious chest complications. These need not be elaborated.

OPERATIVE TREATMENT FOR RECURRENT HERNIA

It is convenient at this stage to mention the operative treatment for a recurrent hernia. The fundamental principles are the disposal of the sac and the repair of the canal.

The preliminary steps are identical in every case—namely, excision of the old scar, thorough and careful delineation of the various anatomical layers (with complete hæmostasis), and the identification of the sac. The identification of the 'direct' sac is often a matter of considerable difficulty.

The next stage depends on the nature of the sac, but in principle it consists of gentle and complete isolation of the sac, separation off of any structure adherent to its peritoneal surface, efficient ligation of the sac as far above the neck as possible and the removal of the sac, the stump of which should then be over-sewn; the stump may be anchored to the under-surface of the muscular layer. When the sac is 'direct' the method to be adopted depends entirely on the anatomical detail of the sac; if at all possible, the direct sac should be excised; the direct sac through a narrow gap in the posterior wall easily lends itself to removal.

The repair of the canal in a true recurrent hernia is necessary. In many of the above cases no repair was required as the sac of the recurrence was identical with that at a primary operation. There are several methods for the repair of the canal: (1) The fascial-graft operation of Gallie entails a double operation, with frequently some mechanical difficulty. (2) Bloodgood's operation involves the use of a fascial flap which is turned down from the rectus sheath; this fascia is sometimes of poor quality and texture, and the exposure of the rectus muscle is thought by some to weaken that region above the symphysis. (3) Another method of using local fascia is that of obtaining strips from the external oblique aponeurosis; this sheet is invariably thin and the length of the strips available is usually inadequate. (4) An excellent method of reinforcement is that where, by means of an incision along the lateral border of the rectus muscle, a fascial sheet can be mobilized which can then be sutured to the inguinal ligament.

In addition to the treatment of the sac and the repair of the canal, there are several technical procedures which may also be employed to render recurrence unlikely: (*a*) On account of the suspected weakness in the transversalis fascia which remains after the removal of the indirect primary sac, it is recommended that this fascial layer should be carefully repaired at the level of section of the sac; the sutures may be passed between the structures of the cord if necessary. (*b*) Some plication of the transversalis layer may be attempted in the middle and medial zones of the canal and the sutures may also be passed between the tissues of the cord while plicating the fascia. (*c*) The outer side of the internal ring may be narrowed by one or more sutures. (*d*) Part of the pampiniform plexus may be excised to reduce the bulk of the cord. (*e*) The external oblique flaps may be overlapped to ensure additional strength and to reconstruct the superficial ring.

In the repair of the canal, I personally favour the fascial 'slide' operation, preceded by a 'pick-up' suture between the transversalis fascia and the cord and a narrowing of the deep ring on its outer aspect. The musculotendinous layer is not placed behind the cord where anatomically it was never meant to lie. Where the spermatic cord appears bulky I never hesitate to excise most of the venous trunks; an overlap of the external oblique flaps is a most useful reinforcement. Finally, a small subcutaneous drain for 48 hours from the lateral angle of the wound may obviate an accumulation of tissue discharge.

THE MANAGEMENT OF THE PRIMARY CASE

The management of the primary case can be more easily understood and carried out if one appreciates the factors which have been shown to be the exciting and contributory causes of recurrence. The treatment should be regarded at all times as consisting of four distinct but intimately connected stages; the failure to conduct any one of these stages in a thoroughly competent manner can only lead to subsequent trouble.

1. Selection of Cases.—It is obvious that no rigid standards regarding the suitability of a case for operation can be laid down; the factors of age, employment, general physique, local muscular development, and the details of the hernia must all be taken into consideration. The most suitable age-period is from approximately 20 years to 30 years; unless in exceptional cases, the musculature of cases in this group is likely to be satisfactory, the hernia will be small, and the patient will be a fit man. Beyond this period one cannot be dogmatic; generally speaking, patients with intercurrent disease or serious previous illness, a poor muscular physique, a tendency to stoutness and increasing weight, and a large hernia should not be subjected to operation, but should be treated with a well-fitting truss, made to exact measurement and supplied by a reputable firm. A truss should never be regarded as an adequate substitute for operation.

2. Pre-operative Treatment.—Too little attention has been paid in the past to the preparation of the patient for operation. He should be admitted to hospital not less than 5 days before the date of the proposed operation; this allows him to become thoroughly acquainted with the atmosphere and general nursing drill of the ward.

The patient should be strictly confined to bed for 3 days before operation and during this period he should receive instruction from one of the staff of the rehabilitation or massage departments in carrying out those muscular exercises which will form a major part of the post-operative treatment. The exercises are designed to improve the muscles which will be involved at operation; all can easily be performed in bed, subsequently during convalescence, and later when medical supervision is no longer required; no special apparatus is necessary. These exercises are given in principle in the section dealing with post-operative treatment.

The only other factor in the management of this stage is the choice of a suitable anæsthetic. The case should be thoroughly examined by the anæsthetist as a routine 3 days before operation and a daily visit made to the patient in the interval; tobacco consumption should be reduced to a palatable minimum. After the type of anæsthetic has been selected, if need be in consultation with the surgeon, some simple information thereon imparted to the patient helps greatly to maintain his confidence.

It may be argued that to bring a case into hospital for so many days before operation is a wastage of working-hours and the filling of a bed which may be more urgently required, but I now firmly believe that this pre-operative period is indispensable and that it should never be omitted.

3. The Operative Technique.—This has already been discussed in some detail under "Operative Treatment for Recurrent Hernia", and the principles of that technique are all applicable to the treatment of the primary case.

The operation should be delayed if there is the least suspicion of respiratory infection or if any adverse weather conditions prevail; if no 'clean' surgical ward exists the case must be isolated to avoid a possible 'cross-infection'.

Nothing can alter the essential principle regarding the disposal of the sac, and this is considered so important as to be worthy of repetition. The sac must be identified, isolated, transfixed, and completely removed as far above the neck as possible; the stump should be oversewn and it may be anchored to the under-surface of the muscular layer, although some surgeons prefer to let it drop back. Unless the sac has been dealt with in the manner described, the surgeon cannot be said to have fulfilled his obligation to the patient.

Some elaboration is required, however, of the method of dealing with the canal. Hitherto, as a general rule in a muscular patient with a small, simple, well-developed sac, and a firm deep inguinal ring, no additional repair work has been considered necessary in a primary hernia; however, the trend of present-day surgical opinion is towards a repair of the canal by any one of the accepted methods or at least the treatment of the transversalis fascia and deep abdominal ring as a routine measure.

I regard the Bassini operation as totally inadequate. Neither should there be any need to repair a primary hernia by a Gallie fascial graft. Strips of local fascia from the external oblique layer have been shown to be of poor quality and too short. There remains the fascial flap method from the rectus sheath or the 'slide' operation, and either of these is satisfactory. Whether a fascial operation is done or not, there should be an accurate repair of the transversalis fascia at the deep inguinal ring, which should then be narrowed on its lateral aspect. The repair of the canal will minimize the chances of a direct recurrence and the treatment of the ring and the fascia will obviate an indirect recurrence. Any of the minor additional refinements, previously mentioned, may be added.

Suture Material.—Another matter about which there has been considerable difference of opinion has been the question of suture material. What material should be used—ordinary catgut, chromicized catgut, silk, floss silk, cotton thread, or linen thread? Should it be 'mixed' in the same operation?. Ordinary catgut may rapidly become digested, allowing the tissues to give way, and many surgeons consider it unreliable; chromicized catgut is more durable, but even that is regarded as being unsafe; floss silk, as far as can be ascertained from personal discussion, seems not to be in favour; some support has recently been given to the use of cotton thread. Fascial repairs are probably best done with silk or linen thread, but all unabsorbable material raises the

question of retained foreign matter, possible sepsis, and sinus formation. For ordinary cases, not requiring any repair, there appears to be no reason why chromicized catgut should not be adequate. The 'weight' of the suture used is entirely one of personal preference. It cannot be said, however, that the use of unsuitable material is one of the chief causes of recurrence.

4. Post-operative Treatment.—The immediate sick-nursing of the case need not be considered. In the simple uncomplicated herniotomy the patient should be confined to bed for not less than 16 days; this period should be extended to 21 days or even a few days longer in the case of a repair operation with a large sac or in a recurrent hernia.

Remedial exercises should commence not earlier than the tenth day, although during the intervening period the patient will have been able to perform some minor leg and trunk movements; it should be clearly understood that exercises in themselves are not likely to prevent a recurrence. The muscles to be rehabilitated are those comprising the abdominal wall. All exercises are done on the back.

It is not intended to give an elaborate programme for these exercises, but it should be arranged in conjunction with a qualified instructor. The individual group exercises should be repeated on an average of four or five times per exercise, with short periods of rest between each, and the whole group repeated every 3 or 4 hours. In brief, the exercises are: (*a*) leg, thigh, and trunk movements to restore the recti muscles; (*b*) lateral rolling of the legs, together or separately, for the internal and external oblique muscles; (*c*) abdominal contractions, associated with respiration, for the transversi muscles.

By the time the patient is ready to pass on to convalescence the exercise routine will be well established; close co-operation with the personnel of the convalescent institution is essential; on his return home, the patient can easily continue his own treatment, reporting at intervals to the surgeon or to the rehabilitation centre of the hospital.

A simple but effective method of grouping post-operative cases to ensure continuity of treatment is that of classifying them according to the nature of the hernia in relation to the type of employment and the probable date of return to work; the patient is placed in the appropriate category by the surgeon before he leaves the hospital, and this serves as a guide during the subsequent phases of treatment.

CONCLUSIONS

1. In approximately 50 per cent of the cases investigated, the recurrence could have been avoided by competent surgery.

The chief cause of recurrence in 33 cases out of 52 (63 per cent) of oblique hernia has been the inefficient surgical treatment of the sac.

Other contributory causes have been faulty selection of cases for operation, inadequate methods of dealing with the inguinal canal, and a residual weakness of the transversalis fascia; some of the 'direct' recurrences can be included in this group.

2. The surgeons responsible for these cases had not been conversant with the principles of treatment for the primary condition. The operation is not an easy one and requires considerable judgement; it should not be allocated to an inexperienced junior or to an enthusiastic house surgeon.

3. Excluding the recurrences due to the failure to cope with the oblique sac and those of a direct nature from previous operative faults, it is found that the incidence of 'oblique' hernia is nearly double that of the 'direct' variety.

4. The age of the cases investigated had no apparent relationship to recurrence.

5. From comparative figures of 'military' and 'non-military' operations, there is no reason to conclude that the high recurrence rate is due to one particular group or status of surgeon.

6. Muscular rehabilitation has a definite place in the treatment of hernia.

7. The number of recurrent hernias still remains too high and every possible precaution is required in all phases of the treatment of the primary lesion.

SUMMARY

1. A series of 70 cases of recurrent hernia, personally treated, has been investigated with regard to the possible factors likely to have influenced the recurrence.

2. The treatment of the recurrent case has been outlined.

3. The fundamental principles for the management of a primary hernia have been elaborated in the light of the information obtained from the investigation.

A CASE OF CEREBROSPINAL FEVER WITH THROMBOSIS OF THE RIGHT AXILLARY ARTERY, FOLLOWED BY GANGRENE OF THE RIGHT ARM, NECESSITATING AMPUTATION

By ARTHUR LEVIN
MEDICAL REGISTRAR, ROYAL MASONIC HOSPITAL
AND LIEUT. DONALD M. McELROY
U.S. ARMY MEDICAL CORPS

WE feel that it is of interest to record this case because cerebrospinal fever is a common disease of total warfare. Also, there was an unusual complication which, as far as we can gather, has not been previously reported.

CASE REPORT

HISTORY.—The patient, a Colonel, 47 years of age, was admitted to the Royal Masonic Hospital in the morning of Feb. 9, 1943, in a semicomatose condition. There was no knowledge of contact with cerebrospinal fever, but we learned later that he had not been feeling well during the previous week. On the night before admission, he felt very tired and had gone to bed early. The next morning his landlady found him unconscious, and called in a medical officer, who had him transferred to hospital.

ON ADMISSION.—He was obviously very ill and unable to talk coherently. He was lying on his back, with his legs slightly flexed, and some degree of head retraction was present. The temperature was 100° F., pulse-rate 110, and respiration-rate 20. The pulse volume was poor.

A petechial rash was noticeable over the trunk and limbs, especially marked over the dorsum of both feet. There were also small hæmorrhagic areas up to 4 mm. in size on the arms and forearms, more prominent in the antecubital fossæ. The eyes were half closed. The pupils were small, central, circular, equal, and reacted to light. The fundi were normal. The tongue was furred and dry, and the throat injected. No enlarged glands were present in the neck. Lung fields were clear, except for a few râles at the left base. The heart was not enlarged, the sounds were normal, and there were no murmurs. The blood-pressure was 95–60. The abdomen was soft, there was no tenderness, and no enlargement of the spleen or liver. Examination of the nervous system showed all the deep reflexes present, equal, and increased in tone. The abdominal reflexes were normal, and the plantar response was flexor on both feet. Kernig's sign was positive, and Brudzinski's 'neck' and 'leg' signs were both elicited.

SPECIAL INVESTIGATIONS.—

Urine.—The urine was acid, contained a trace of albumin, and was green to Benedict's solution. There was no acetic or diacetic acid and no blood. Centrifuged deposit showed scanty red blood-corpuscles and white blood-corpuscles. There were no organisms.

Spinal Fluid.—Lumbar puncture was carried out and a thick purulent blood-stained fluid was obtained. The fluid dripped slowly from the needle, but the pressure was not taken as the patient was difficult to control. Microscopical examination showed numerous cells, mainly polymorphonuclears and Gram-negative diplococci in moderate numbers, these being intra- and extra-cellular. Culture from the spinal fluid produced a good growth of meningococci.

Blood.—

Blood-count:

White blood-corpuscles	30,000 per c.mm.
Neutrophils	93 per cent
Lymphocytes	5 „ „
Monocytes	2 „ „
Red blood-corpuscles	5,360,000 per c.mm.
Hæmoglobin (Haldane)	100 per cent
Colour index	0·99

Blood culture: Revealed growth of meningococci after twenty-four hours' incubation.

PROGRESS AND TREATMENT.—As the patient was unable to take fluids by mouth, an intravenous glucose-saline drip was started. Soluble sodium sulphapyridine was given via the glucose drip tube, a total of 7 g. of the drug being given during the first twelve hours. The first 5 g. were given into the left arm via the tube of the intravenous solution, which was later discontinued. The next 2 g. were given directly into the antecubital vein of the right arm, at a dilution of 1 : 3. This was followed by two intramuscular injections of 2 g. each, at four-hourly intervals, into the gluteal muscles. A total of 17 g. of this drug was used during the first two days in hospital.

Because there was no appreciable improvement in his general condition, the drug was changed on the third day to soluble sodium sulphadiazine, this drug being equally effective and less toxic (Finland and Dingle, 1941). He was given two intravenous injections of 4 g., followed by two intravenous injections of 2 g. at four-hourly intervals. The drug was then continued by mouth, a total of 51 g. being given over the next sixteen days.

On the night of admission he was very restless and was given morphia. About 12 p.m. it was noted that he sweated profusely, after which his skin felt cold, and extra warmth was applied. At 4 a.m. his right arm was found to be flaccid, and colder than the rest of his body.

The next morning the patient's condition appeared to be about the same. He was unconscious and still restless. The right arm was seen to lie immobile by his side and felt cold. Neither the radial nor brachial pulse was palpable, but some pulsation was felt high in the right axilla. The skin was pale, the muscles were firm, and no œdema was present.

It was apparent that there was a circulatory disturbance in the right arm, and the question of surgical interference was considered, but decided against as the nature of the condition was so uncertain and it was thought probable that infection was present. Thus the arm was left covered with a thin layer of cotton-wool. On Feb. 11, three days after admission, a definite line of demarcation was first seen, about 2 in. above the elbow-joint.

On Feb. 12, the patient regained consciousness for the first time, and noticed he was unable to move his arm. He did not complain of any pain. Examination of the arm at that time showed some contraction

and stiffness of the fingers and of the wrist- and elbow-joints. The forearm was held in the mid-prone position, with the elbow semi-flexed. The skin of the arm was cooler than the rest of the body, and a slanting line of demarcation was seen passing round the middle of the arm.

From this time on, the patient's general condition improved rapidly, but the right arm was obviously becoming gangrenous. The line of demarcation at first moved peripherally about 1 in., but later rose higher on the arm, and by Feb. 22 it seemed to be stationary, and the condition at amputation was that as seen in the coloured photograph (*Fig.* 200).

down any of the brachial nerve-cords, the large nerves being simply cut across with a sharp knife. The anastomotic circulation was good and the wound bled freely. Hæmostasis was secured and skin-flaps were closed with silkworm-gut sutures, without drainage.

The immediate post-operative condition was excellent, and progress was satisfactory until five days after the operation, when the patient had a sharp pain in the right chest which lasted fifteen to twenty minutes, and the following day, he coughed up a small amount of blood-stained sputum. Decreased air entry was noted in the lower right chest. The condition was thought to be due to a small

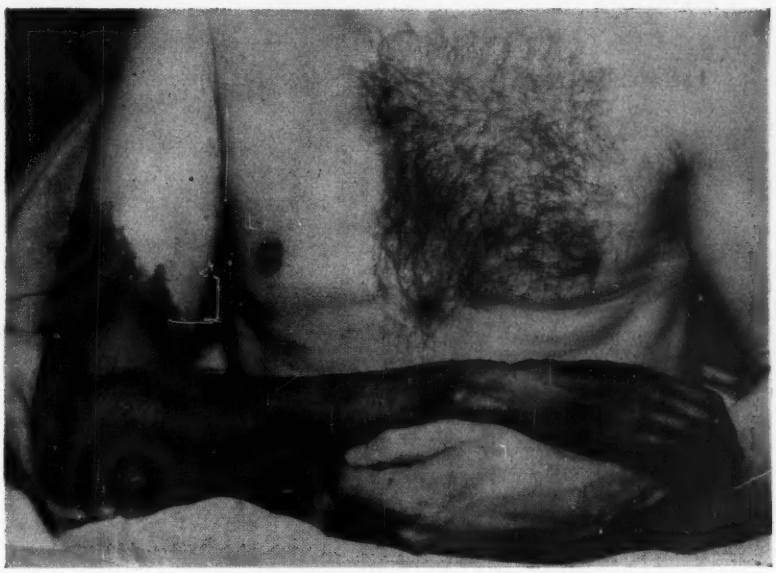

FIG. 200.—Condition of arm the day before operation. The axillary hair and that of the right pectoral region has been shaved.

Other interesting points of the case were :—

1. *Arthritis* : About three to four days after admission there was noticed swelling and tenderness of the right ankle-joint, which subsided in a few days.

2. *Pneumonia* : On the second day the patient was noted to have some consolidation in the base of the left lung. Unfortunately, no sputum could be obtained, as the patient was still unconscious. However, resolution occurred without further incident.

3. *Retention of Urine* : This occurred during the first twenty-four hours and periodic catheterization was necessary. Bright red blood was obtained during one of the catheterizations, and microscopical examination showed red blood-cells but no casts or sulphapyridine crystals. This bleeding was thought to be due to trauma owing to the extreme restlessness of the patient during the catheterization. The blood cleared from the urine in a few days.

AT OPERATION.—On Feb. 22, under general anæsthesia, amputation of the right arm was performed by Surgeon Rear-Admiral Cecil P. G. Wakeley. The arm was removed, leaving approximately 2½ in. of the head and neck of the humerus : the insertion of the deltoid muscle had to be sacrificed. The brachial artery and venæ comites were completely thrombosed up to the middle of the axillary vessels and were surrounded by dense adhesions ; these were not separated for fear of injuring the cords of the brachial plexus. No attempt was made to pull

pulmonary infarction. No further symptoms occurred, and from then onwards he made an uninterrupted recovery. The wound drained a moderate amount of serosanguinous exudate, which gradually diminished, leaving sound union. There was some phantom pain which was controlled by mild sedatives.

On March 3 lumbar puncture showed crystal-clear fluid under no increase in pressure ; 57 mononuclear cells were present, but no organisms on smear or culture. The patient made good progress and was discharged on March 26, having recovered completely, and feeling quite well.

AETIOLOGY

The cause of the occlusion of the vessels in the right arm is a subject for discussion. It is impossible to state the exact time of onset of the occlusion, but since some circulatory disturbance was noted on the night of admission, it occurred probably within the first twenty-four to forty-eight hours of illness.

The conditions to be considered are those of embolism and thrombosis. There was no evidence of any heart lesion which might have produced an embolus big enough to block a large artery ; therefore, one may assume that a thrombosis took place, and this was borne out by

microscopical examination of sections from the amputated limb. These showed that parts of the clot in the vessels were laminated, with some infiltration of polymorphonuclear leucocytes into the vessel walls and surrounding tissue, indicating that the lesion was primarily a local thrombosis.

This thrombosis is difficult to explain. The injection of sulphapyridine into the right antecubital vein has been considered as a possible cause, but it is not easy to see how arterial involvement could have occurred. There was no doubt that the substance was injected directly into the vein, and this was verified later by examination of the vessels in the amputated limb.

McMeans (1916) discusses the occurrence of arteritis in meningitis, and considers that involvement of the intima of the vessels, with disorganization of this layer, is a significant cause of thrombosis. He states that narrowing of the blood-stream at irregular points and the abnormal clotting reaction of inflamed tissue are additional factors.

It is interesting to note that Murray (1929) states that agglutination of human serum may cause the formation of minute meningococcal emboli, which plug smaller peripheral vessels. We suggest that, in our case, on account of the severity of the blood-stream infection, such emboli impaired the blood-supply to larger vessels, resulting in damage to their walls and subsequent thrombosis.

SUMMARY

1. A severe case of cerebrospinal fever and its treatment are reported.

2. The occurrence of thrombosis of the right axillary artery, followed by gangrene, which necessitated amputation of the limb, is described as a rare complication. The possible causes of the thrombosis are discussed.

We should like to thank Surgeon Rear-Admiral Cecil P. G. Wakeley and Dr. W. E. Lloyd for permission to publish the case, and for their kind assistance. We should also like to express our thanks to Brigadier-General Paul R. Hawley, Chief Surgeon, American Forces, European Theatre of Operations.

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HUMERO-RADIAL SYNOSTOSIS

BY E. FRANKEL
PHYSICIAN, ESSEX COUNTY HOSPITAL, WANSTEAD

CONGENITAL humero-radial synostosis is a rare abnormality and so far only 22 cases have been described. A review of the literature shows that humero-radial synostosis occurs in conjunction with other deformities of the limbs. The affected arms are shortened and in the majority of cases the deformity is accompanied by a rudimentary ulna and a faulty development of the carpal bones and fingers. In all cases the humerus continues into the radius without a change in the structure of the bone. It affects the sexes equally and is found in one arm only in the majority of cases. A hereditary tendency was reported by Siwon (1928), who described the occurrence of humero-radial synostosis in a girl and her mother. No exogenous cause for this deformity was discovered. The following case, with a description of the family of the patient, throws some interesting light on this rare condition.

CASE REPORT

G. M., aged 23, a clerk, came under my care on April 1, 1943. For a month previous to admission he had complained of weakness, fatigue, and anorexia, and was forced to give up work two weeks later. His complexion became sallow, he developed a sore throat, and had frequent attacks of epistaxis. He vomited and had several hæmatemeses. He was constipated and complained of headache. His previous health had been good.

ON EXAMINATION.—He was found to be an ill-looking young man of normal size and stature. His breath had a uriniferous odour, and his tongue was dry and covered with a brown fur. He had injected fauces covered with inflammatory exudate and sordes on his lips. His skin was dry. Petechiæ were seen on his legs and on the palate. There was blood in his right nostril and his lips and gums were also bleeding. His pulse was slow and regular. His apex beat was forceful and slightly displaced to the left. A soft systolic murmur was heard at the apex. His blood-pressure was 190/110. Nothing abnormal was found in his lungs, abdomen, and central nervous system. His pupils were small and equal, and his fundi were normal. He had bilateral humero-radial synostosis and his elbows were flexed at slightly less than a right angle. There was marked wasting of all the muscles of the arm normally used in movements of the elbow, due to disuse atrophy. The humerus was shorter and thinner than normal, but the shoulder and wrist joints, forearms, and hands were quite normal. In addition, his left patella was absent. The right patella was small and on flexion of the knee was displaced laterally over the condyle of the femur. In view of his condition a diagnosis of uræmia due to chronic nephritis was made. This was confirmed by a blood-urea of 265 mg. per 100 c.c. He had

albuminuria and his urine contained red blood-corpuscles, pus cells, and casts.

Shortly after admission he developed a severe, bilateral, suppurative parotitis and died.

POST-MORTEM EXAMINATION.—His face was puffy and swollen owing to purulent inflammation of both parotid glands. A small amount of fluid was present in each pleural cavity. His lungs showed bilateral basal congestion with early bronchopneumonic

FIG. 201.—G. M., photograph of bones of the right elbow.

changes. The pericardium was normal. The heart was big and weighed 14½ oz. There was concentric hypertrophy of the left ventricle. The valves, coronary vessels, and aorta were normal. Both kidneys were very small and together weighed only 70 g. The normal renal architecture had gone and the appearance was typical of the primary contracted, small white kidney. The capsule stripped with difficulty and left a coarse, granular surface with small cysts. Microscopical examination showed the loss of many glomeruli in the cortex, great atrophy of the tubules, fibrosis, and slight lymphocytic infiltration in the interstitial tissue. Granular and hyaline casts were seen in several cortical tubules. Slight end-arteritis was found in many interlobular arteries and hyaline degeneration of a few arterioles. The spleen and liver were normal. Both arms were short, wasted, and symmetrical. The shoulder girdle was normal. One abnormal joint was removed and showed typical humero-radial synostosis (*Fig.* 201). The ulna was small and was also fused with the humerus. An X-ray picture shows the complete absence of a joint space (*Fig.* 202).

Family History.—The patient came of healthy stock. There were no consanguineous marriages in his family, going back three generations, and both his father's and mother's families are distinguished by longevity and a great number of offspring. No similar abnormality had ever occurred in previous generations of his family, nor was there evidence of hereditary disposition to any disease or abnormality. Both his father and mother are healthy, normal people, but four of their seven children show the same deformities.

The first born was a girl, now 27 years of age, who is normal. Next came a girl who had humero-radial synostosis. She died at the age of 10 of hæmorrhage following tonsillectomy. It was suggested that she also had kidney disease. She would have been 25 years of age. The following child was my patient, G. M., who died at the age of 23. The next child, a boy of 21, is quite normal. Then comes a boy, J. M., aged 19. He is a spectacle-frame maker.

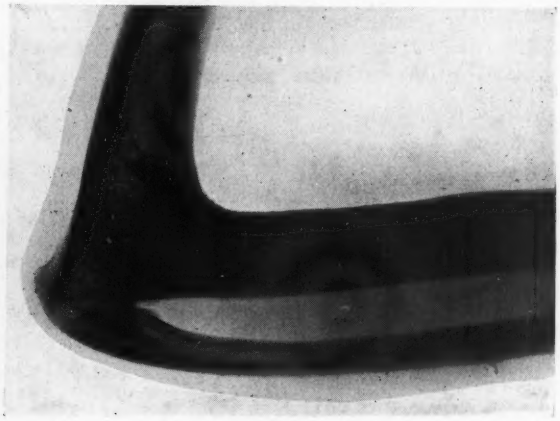

FIG. 202.—G. M., radiograph of right elbow.

He has had no serious illness and is of normal size, stature, and intelligence. His arms and elbows show the same deformity of humero-radial synostosis, which

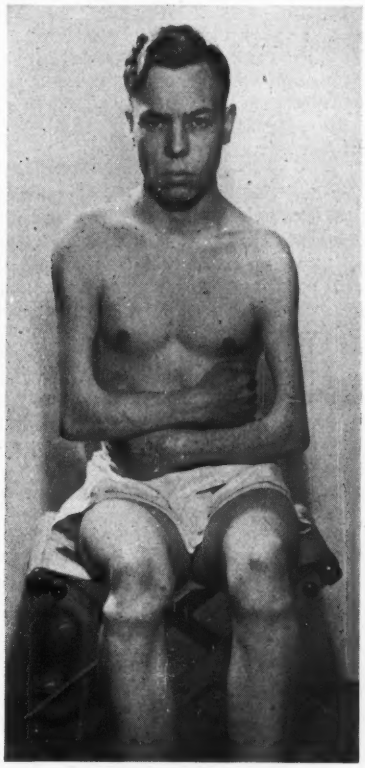

FIG. 203.—J. M., Photograph showing the typical deformities.

does not appear to worry him. The angle between humerus and radius is a right angle and radiography shows the absence of a joint space. The picture is almost identical with the film taken of his brother's elbow. Both his patellæ are present and well formed,

but there is lateral subluxation of his right knee-joint. He can produce the luxation at will and keep the knee-joint in the abnormal position (*Fig.* 203). Nothing else was found on physical examination. Both fundi were normal and his blood-pressure was 150/70.

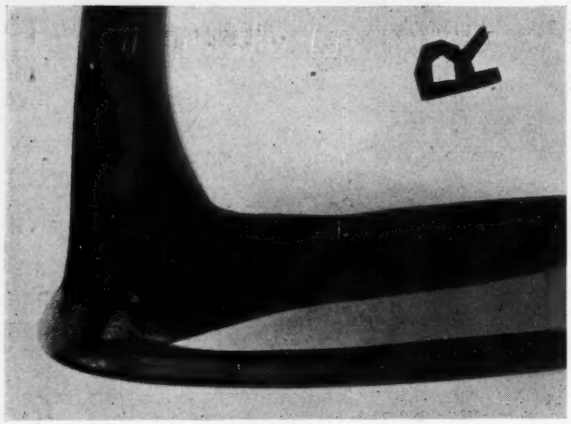

FIG. 204.—B. M., radiograph of right elbow.

The following investigations were done: The urine was acid. There was considerable albuminuria and occasional leucocytes and epithelial cells were seen. A culture was sterile. A blood-count gave 4,300,000 red cells; Hb 77 per cent; C.I. 0.9; white cells 6400 (per cent—polymorphs 51, lymphocytes 33, monocytes 7, eosinophils 6, basophils 3). The blood-urea was 240 mg. per 100 c.c., blood-calcium 7·8, and blood-phosphorus 7·4 mg. per 100 c.c. His blood-Wassermann and Kahn reactions were negative. A water-concentration test of renal efficiency (Volhard) showed a maximum concentration of 1·012. In a water-elimination test (Volhard) the lowest concentration of the urine was 1·002, but only 400 c.c. of the 1200 c.c. of water administered were excreted in four hours. A urea-clearance test (van Slyke) gave 36 per cent of the normal clearance. A urea-concentration test (Maclean) yielded 1·19, 1·19, 1·45 per cent of urea. These investigations prove that gross deficiency of renal function is present, and it is probable that his brother's fate is also in store for him. It is noticeable that the high blood-urea has not given rise to any signs or symptoms of uræmia.

The last two children are twins, now aged 16. The boy is normal in every respect, but the girl, B. M., has humero-radial synostosis and abnormal patellæ. She has had no serious illness. She feels well and is working as a tailoress. Her appetite is good, she has not lost weight, and her periods are regular and normal. She is an intelligent girl of good development and apart from the bony deformities appears healthy. She again shows the same deformity of the arms and elbows both on physical and X-ray examination (*Fig.* 204). The right patella is rudimentary (*Fig.* 205) and the left is smaller than normal, but the function of the knee-joint is not impaired. Complete physical examination and renal function tests did not reveal any further abnormality.

DISCUSSION

No exogenous causes can be responsible for the development of humero-radial synostosis and the concomitant abnormal findings in the knee-joints. Only a hereditary factor could cause these familial and congenital abnormalities. From the complete absence of a hereditary disposition to the deformities in this family one must conclude that a germinal change has taken place in one of the parents of this family, leading to the production of new characters, or at least a germinal re-arrangement has taken place, making possible the appearance of the new characters. Individuals who possess a very rare dominant condition will nearly always possess the gene which determines it on one chromosome only. Genetic theory demands that half the offspring of such persons, if married to a normal person, will have the dominant trait. Four out of seven children in this family show the deformities, and one of the twins only is affected. In view of the rarity of this condition and the absence of consanguineous marriages in the parentage, it is unlikely to be caused by recessive hereditary factors present in both father and mother, particularly as the genetic theory tells us that if two parents are carriers, only one quarter of their offspring will show the recessive trait.

It is known that in the elbow of a 14-mm.-long embryo no joint space is found. It is also still absent in an embryo 22 mm. long, though

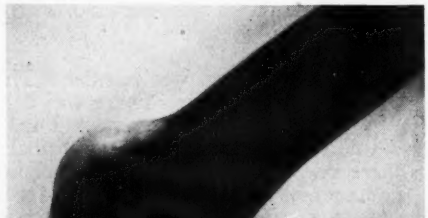

FIG. 205.—B. M., radiograph of right knee.

ossification of the long bones has begun. During the third month of intra-uterine life the elbow-joint is formed. From these facts one can draw the conclusion that the developmental disturbance responsible for the deformities must be active during the first three months of fœtal life. In view of the amazing similarity of the deformities in all affected children, the disturbing hereditary

influence must have been active at the same stage of their development.

Another point of interest is the apparent liability to severe renal disease in these children which is quite independent of the bony deformities. Renal rickets takes no part in the clinical picture. It is known that one and the same gene substitution may be responsible for many and various manifestations, as no gene can be supposed to have a single, specific effect. The germinal changes responsible for the humero-radial synostosis and abnormalities of the patellæ and knee-joints may also have predisposed these children to chronic nephritis at an early age. It seems as if sterilization of the affected individuals is undertaken by nature, as they die before they can propagate their kind.

SUMMARY

A case of humero-radial synostosis is described. The family history is given. Four out of seven members of the family have this deformity. They also show abnormalities of the patellæ and knee-joints. Two of the four afflicted children have died. The cause of death in one of them was chronic nephritis. Another boy is now suffering from chronic nephritis. No similar abnormality has ever occurred in previous generations of this family. The hereditary factors responsible for the condition are discussed.

I wish to thank Dr. D. H. Irwin, Medical Superintendent of Essex County Hospital, Wanstead, for permission to publish this report.

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SPINAL ANÆSTHESIA IN THE TREATMENT OF HIRSCHPRUNG'S DISEASE

WITH REPORTS OF TWELVE CASES

BY MARGARET HAWKSLEY

ANÆSTHETIST (WARTIME) TO THE HOSPITAL FOR SICK CHILDREN, GREAT ORMOND STREET; E.M.S. ANÆSTHETIST, BASE HOSPITAL, HEMEL HEMPSTEAD

SPINAL anæsthesia as a treatment for Hirschsprung's disease was first advocated in America by Stabins, Morton, and Scott (1935). In giving a spinal anæsthetic as a pre-operative test of suitability for lumbar sympathectomy, they discovered that in each of 4 cases tested some degree of clinical improvement ensued. The results were so encouraging that operation was first postponed and then considered unnecessary. In 1 case there was an evacuation on the table, but in the others improvement came gradually. Observation extended over a period of months only, except in one instance when the period was four years. Rives and Strug (1935) reported 2 cases shortly afterwards, both of which had an immediate bowel action and maintained normal habits during the next month. In England Telford (Telford and Simmons, 1939) went much further; he reported 7 cases so treated, 4 of which were completely, and 3 almost completely, cured over periods up to two years after spinal anæsthesia. For the past three years cases of this disease admitted to the Hospital for Sick Children, Great Ormond Street, have been evacuated for treatment to the base hospital. The results of spinal anæsthesia at first appeared to be so poor that it was decided to review the whole matter, to follow up the cases, and to find out what other workers were doing and what their results were. The purpose of this paper, therefore, is to place on record the results of this investigation, to describe fully the technique employed, to discuss briefly some pitfalls in the diagnosis, and to show that encouraging long-term results can be expected. Twelve cases are described and in only one has no improvement occurred.

In order to find out what success other workers were having with this treatment several pædiatric centres in the country were written to; their replies in the main were not encouraging. Manchester, where this form of therapy originated in this country, was the only centre to report good results, and in a personal communication Professor Telford stated that all his own cases were cured and had remained so after three years, and that he had abandoned sympathectomy for this disease. Replies from six other centres varied from "unsatisfactory results" to "no experience" in the use of spinal anæsthesia in Hirschsprung's disease. Accordingly when the cases reported below came up for review, some of them after over two years since spinal anæsthesia, success was not expected. It was therefore surprising and interesting to be able to classify 6 as cured, ranging from three years to nine months since treatment, 3 as improving, ranging from seven to three months, and only 1 as no better—a severe case and complicated by sympathectomy at another centre (*Case* 9). For the remaining 2 cases there has not been sufficient time over which to judge the result.

Generally speaking, it appears that neither an immediate evacuation on the table, nor a rapid improvement afterwards, should be expected (Stabins et al., 1935; Rives and Strug, 1935), and that a long-term view should be taken. Only *Case* 1 passed a motion on the table and continued with normal habits. All the others showed no particular change until at least a month (*Case* 2), and some took even longer. *Cases* 7 and 9 passed flatus and showed decrease in abdominal distension while under the spinal, but *Case* 7 is only to be claimed as improving and *Case* 9 is unchanged. The clinical histories, however, best indicate the manner in which benefit occurs.

CASE REPORTS

Case 1.—N. H., male, now aged 8 years. First attended 2 years 9 months ago complaining of constipation for the previous three years; his symptoms, therefore, began when he was 2 years of age. He had abdominal enlargement and passed large-calibre motions whenever his bowels acted, which was at intervals of from five to seven days. At one time he had been almost obstructed and at best he required constant doses of paraffin and frequent enemata. Radiograph of a barium enema, performed elsewhere, showed typical megacolon and he was considered to be such a severe case that sympathectomy was advised. On admission, however, it was decided to try spinal anæsthesia first. Accordingly, in February, 1940, 5 c.c. light percaine 1–1500 was injected into the 4th-5th lumbar interspace (S.A.) and anæsthesia obtained up to the 4th thoracic segment. A motion was passed on the table. For the next four days he required enemata, but on the fifth his bowels were open normally and he was discharged. He has been under periodic observation ever since and has had no subsequent abdominal distension. The bowels open once daily and motions are normal in size, though X rays now show the same degree of megacolon (*Fig.* 206). He is a well-grown healthy looking boy.

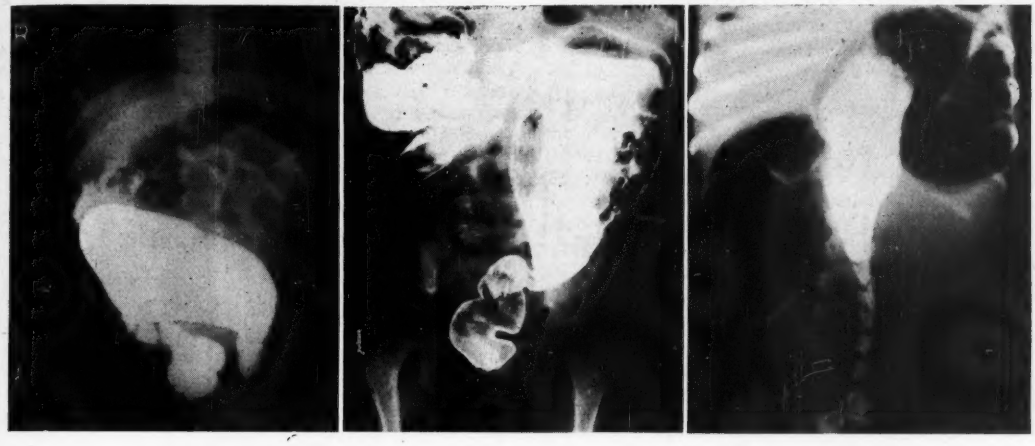
Case 2.—D. W., male, now aged 6 years. First attended 2 years 9 months ago, aged 3½, complaining of constipation since birth, with abdominal enlargement. Bowels open alternate days with difficulty and the motions passed were hard and "bigger than adults". Radiograph showed megacolon. In March, 1940, he was given 0·4 c.c. stovaine (C.W.M.) with resultant anæsthesia up to the level of the clavicles. There was no immediate result and no improvement in the next three weeks. A second injection was made (C.W.M.), using 4·5 c.c. light percaine 1–1500. The bowels were opened while the child was bent forward for passage of the needle, but although there was marked peristalsis after the injection there was no further bowel action. Anæsthesia obtained over chest, but the exact level was not stated. For the week following, his abdomen became less distended and he had occasional spontaneous bowel actions. X rays showed no difference in the condition of the colon and he was discharged with arrangements to have a monthly evacuation under anæsthetic. This, however, was found to be unnecessary as he steadily improved. In December, 1940, he had no abdominal distension and he was having his bowels open once daily. At present, 2 years 9 months after the treatment, he is very well, has no abdominal enlargement, and passes a normal daily motion. He takes a dessertspoonful of paraffin nightly. X rays now show gut of normal size, but with defective haustration, and perfect evacuation twenty-four hours later.

A B C

FIG. 206.—*Case* 1. A, January, 1940. Barium enema before treatment. B, November, 1942. Barium enema, showing the colon still enormous. C, November, 1942, 24 hours after barium enema. Colon only slightly emptied. Child functionally cured for 2½ years (*see* case report).

Case 3.—B. H., male, now aged 3 years. First attended 15 months ago with history of constipation and abdominal distension from birth. He had marked peristalsis and a barium enema radiograph showed typical distended colon with a large residue after twenty-four hours. In July, 1941, he was given 0·5 c.c. stovaine (C.W.M.) and anæsthesia was produced up to the nipple line (T.4). There was no result, and the child was discharged. There has, however, been a steady improvement amounting now (15 months) to cure. The child has his bowels open once daily, passing a normal-sized motion, and only occasionally requires an enema. The abdomen is

not distended, but peristalsis can still be seen from time to time. X rays now show the same readily distensible colon, but excellent evacuation in twenty-four hours with colon contracted in parts (*Fig.* 207).



A B C

FIG. 207.—*Case* 3. A, July, 1941. Barium enema before treatment. B, November, 1942. Barium enema, showing megacolon. C, November, 1942, 24 hours after enema. Almost complete evacuation. Child functionally cured for 16 months. Cf. *Fig.* 206, B, C.

Case 4.—A. D., male, now aged 3½ years. First attended 1 year 3 months ago with symptoms, then of 3 months' duration, of abdominal distension, frothy diarrhœa, and the passage of quantities of flatus. He had a markedly distended tympanitic abdomen with visible peristalsis. His anal sphincter felt normal in tone, but the rectum was ballooned and contained soft fæces. X rays showed megacolon. In November, 1941, he was given 0·5 c.c. stovaine (C.W.M.) and anæsthesia was obtained to the level of the fourth rib. There was no immediate result, and he was discharged to continue with aperients. However, after about one month he began to have his bowels open once or twice daily, passing normal formed motions, and his abdomen decreased in size. Now he is a lively normal child, there is no abdominal distension, he never requires a laxative, and the bowels are open once daily. Owing to travelling difficulties a recent radiograph cannot be obtained.

Case 5.—J. G., female, now aged 6½ years. This case is included in the series as showing possibly an early commencing condition of megacolon with benefit from spinal anæsthesia; it has not got all the typical features of an unequivocal Hirschsprung condition. She was first admitted one year ago with a six-months' history of abdominal swelling, diarrhœa, lassitude, and weakness. The bowels were open after every meal and two or three times at night, and the motions were pale or green; there was no blood or mucus. The abdomen was distended, but there was no visible peristalsis. A barium enema showed dilatation of the sigmoid colon and rectum only, with absence of haustration; the rest of the colon appeared normal. In November, 1941, she was given 0·5 c.c. stovaine (M.H.) and anæsthesia was obtained up to the nipple line (T.4), but with no immediate result. At that time (1941) a motion on the table was expected, and, therefore, the spinal injection was repeated (M.H.) on Nov. 6 and Nov. 11 with satisfactory anæsthetic results but no bowel action. She was then discharged to a convalescent home and in the following January was having normal bowel actions daily. Now, after one year, she is not distended, has a normal daily bowel action, and is a bright and active child. Barium enema shows distensible gut, no haustration, and complete evacuation after twenty-four hours.

Case 6.—A. S., male, now aged 11 years. This is a severe case in which only gradual improvement can be claimed. He was first seen in February, 1942, with symptoms of two years' duration, although his story of alternating diarrhœa and constipation suggests that megacolon may have been present earlier. His complaints were increasing abdominal enlargement with attacks of vague abdominal pain, and obstinate constipation sometimes for as long as three weeks. In between times there would be some diarrhœa with incontinence, particularly after medicine. The abdominal enlargement at times prevented him from buttoning his trousers. He was listless and miserable. On examination he was found to be a pale, thin, undersized child, which enhanced the abdominal enlargement, his girth at the umbilicus being 32½ in. instead of the average 22 or 23 in. Peristalsis was a marked feature. There was ballooning of the rectum, which was full of soft fæces. X rays showed marked degree of megacolon with absent haustration. In April, 1942, he was given 10 mg. decicaine in 2 c.c. cerebrospinal fluid (M.H.) into the 2nd–3rd lumbar interspace. Anæsthesia was obtained up to the level of the second rib, and there was ample evidence of anterior root involvement. There was no result, and he was discharged later to continue liquid paraffin at home. In June, 1942, he was again seen and although he still had abdominal distension this was considerably less and he was able to wear trousers of smaller waist-girth. His bowels were often open spontaneously, although there seemed little expulsive action, his mother having to remove the hanging fæces manually. This is the only child with such a symptom; possibly there is some psychological element concerning this bodily function as he prefers to defæcate standing up. He was re-admitted in July, 1942, and 7·5 c.c. light percaine 1–1500 was given into the 2nd–3rd lumbar interspace (M.H.). Again there was ample evidence that the anterior roots were affected, though there

was no spectacular result and the boy was later discharged. Now, there is quite certainly an improvement but not a cure, and a third spinal anæsthetic may be given in the course of a few months. He is much less distended, his mother, though she is overenthusiastic, says that he is brighter and more energetic, his bowels are open once daily, and he no longer has abdominal pain. He takes liquid paraffin once daily.

Case 7.—J. E., male, now aged 5 years. First attended 5 months ago complaining of a large abdomen since birth. Bowels always constipated, never opened without medicine. From time to time they would become even more obstinate and require stronger purgatives, abdominal massage, and rectal suppositories, and after evacuation with the passage of large quantities of flatus the abdominal enlargement would be a little less. In June, 1942, he was admitted and found to be undersized, pale, and miserable, with a very distended tympanitic abdomen and marked peristalsis. X rays showed a huge colon with no haustration, and a poor evacuation. In June, 1942, he was given 5 c.c. light percaine into the 2nd–3rd lumbar interspace (M.H.), with satisfactory anæsthetic result up to the second intercostal space. There was marked peristalsis but no other result. In July he was much improved in general health, his abdomen was less swollen, and he was having his bowels open spontaneously with normal-sized stools. He was still having paraffin daily and a bi-weekly washout. In October he was re-admitted for a second spinal anæsthetic, 5 c.c. light percaine being used as before (M.H.) and anæsthesia obtained to the nipple line. There was very marked peristalsis, and this time a rectal examination was made, a few soft fæces removed, and the pelvirectal junction stretched manually, although it did not show any marked spasm. With the next wave of peristalsis quantities of flatus were passed and the abdomen collapsed like a pricked balloon, the girth at the umbilicus contracting from 25 to 21 in. The next day, however, the girth was up again to 24½ in. and the abdomen tympanitic all over. He was kept in for two weeks, during which time he had washouts on alternate days with considerable passage of flatus and consequent decrease of abdominal girth. He gained 2½ lb. in weight and was much improved in general health and brightness. He has not, since then, had any spontaneous actions, but this case is still under review and improvement can be claimed.

Case 8.—M. McF., male, now aged 2 years. This boy is said to have had an imperforate anus at birth operated on successfully by his own doctor; it appears perfectly normal now on examination and there is no scar. His mother complained that he had been constipated from birth with a distended abdomen. In February, 1942, he was found to have a large abdomen with visible peristalsis, and a radiograph showed dilatation of the sigmoid colon. In May he was given 3 c.c. light percaine (M.H.) into the 2nd–3rd lumbar interspace, with resultant anæsthesia up to T.2. There was no immediate result, but he had his bowels open daily thereafter. He went home to have enemata three times a week, but after six weeks two a week were sufficient as his bowels were often open spontaneously. In October he was re-admitted and the spinal anæsthetic repeated with the same quantity and the same result. A rectal examination was made, a few fæces removed, and the pelvirectal junction stretched. There was marked peristalsis, but although a flatus tube was passed very little flatus was expelled. He was discharged, and in November, 1942, was passing daily motions of normal calibre. Improvement can be claimed, but much more time must pass before final adjudication.

Case 9.—W. S., male, now aged 7 years. This is the only case in which so far there is no improvement whatever, though it is only one month since his last spinal anæsthetic. He had constipation from the age of four weeks coinciding with a change from breast to artificial feeding. When 2½ years old he had bouts of vomiting and diarrhœa and was treated for fifteen months for "abdominal tuberculosis". For the year prior to his first attendance, September, 1940, he required an enema once a week, following on several days complete constipation with vomiting and increasing abdominal distension. On admission he had a very distended abdomen, with visible peristalsis and palpable fæcal masses. X rays showed a vastly dilated sigmoid and descending colon. There was a scar from an anal abscess, but the sphincter was not unduly spasmodic. In November, 1940, he was given 0·5 c.c. stovaine (C.W.M.) with anæsthesia over the thorax. There was no result and he was discharged to have medical treatment. In June, 1941, he was evacuated to Ipswich and at that hospital he was operated upon and resection of presacral and inferior mesenteric nerves performed. There was an immediate improvement, but this was not maintained, and in August, 1942, he was back precisely where he was before—that is to say he was enormously distended, had visible peristalsis, and never had a spontaneous bowel action. In October, 1942, he was given 6 c.c. light percaine (M.H.), with anæsthesia up to the clavicles. A rectal examination was made and fæcal masses removed, following which there were several marked waves of peristalsis and considerable passage of flatus, with decrease of abdominal distension. There is, however, no improvement so far, he never has a spontaneous action of his bowels, and the distension is as marked as ever.

Case 10.—C. C., male, now aged 10 years. This boy had abdominal distension with vomiting from birth, and eighteen months ago was an undersized child with a huge abdomen and positive X-ray evidence of megacolon. Sympathectomy was considered, but it was decided to try spinal anæsthesia first, and this was given by Dr. Ivor Magill in June, 1941, using 7 c.c. light percaine 1–1500 after sufficient intravenous pentothal to render the boy unconscious. In November, 1941, he was again seen; he had gained in weight and his mother stated that "he had never missed a single day's bowel movement since the anæsthesia". In January, 1942, there was still some distension, though less than before the treatment. X rays at that time showed the gut to be smaller, but Dr. Paterson adds that as they were not taken by the same person the pictures are not strictly comparable with the original plates. The father, writing in November, 1942, states that "the immediate results of the spinal anæsthetic were so pronounced that in my enthusiasm I could have broadcast tributes to those who had a hand in it, but I cannot help feeling that this miraculous improvement has not been maintained, or that the result produced has remained stationary". But he also says that if the child had not got to take a number of constipating medicines he would require no assistance at all, and that when he desisted from these patent medicines in the summer he required no laxatives. The conclusion seems obvious! Were the child a hospital patient the spinal anæsthetic would probably be repeated, though the result of the first seems to be sufficiently good.

Two further cases should be described, though there is as yet insufficient time over which to assess their improvement or otherwise.

Case 11.—R. R., male, now aged 2 years. Constipation since birth, with distended abdomen and visible peristalsis. Radiography of a barium enema shows megacolon. In September, 1942, he was given 3 c.c. light percaine (M.H.) into the 2nd–3rd lumbar interspace, with anæsthesia above the nipple line. There was no spectacular result, and he was sent home to have enemata if required.

Case 12.—C. S., female, aged 2¼ years. This case had dribbling incontinence of fæces since she was 5 weeks old, an uncommon symptom. On examination she had an enormous abdomen with visible peristalsis, and X-ray examination showed an elephantine colon. In September, 1942, she was given 3 c.c. light percaine into the 2nd–3rd lumbar interspace (M.H.). Anæsthesia was obtained up to T.3, there was marked peristalsis, and an action on the table. Her subsequent career is still to be followed.

TECHNIQUE OF HIGH SPINAL ANÆSTHESIA

The available literature is silent on this important matter; Telford and Simmons (1939) state that decicaine was used for their cases, but give no doses or percentages, adding that "the nature of the drug used is probably immaterial but it is essential that the upper limit of anæsthesia should reach the anterior root of T.6". Court and Haslar (1942) describe a recent successful case, saying "no guide to exact dosage was available". As described in the case histories in this series, different reagents and methods have been tried from case to case, but accumulated experience has led to the technique about to be described and which gives the most certain anæsthetic results.

What is required? The colon and rectum are innervated by the two antagonistic halves of the autonomic nervous system, the sympathetic inhibiting colonic movements and initiating closure of the sphincters, the parasympathetic initiating intestinal movements and opening the sphincters; the "filler" and "emptying" nerves, according to Telford (1939). The theory on which spinal anæsthesia is based is tentatively put forward by Telford (Telford and Simmons, 1939; Telford, 1939) and others as an imbalance between the two halves of the autonomic system, with overaction of the sympathetic. It is suggested that by temporarily paralysing the offending half the parasympathetic can exercise its function unchecked and that on recovery of the sympathetic the two halves are restored to normal balance. The fibres of that part of the sympathetic concerned with the colon originate in the spinal cord from segments T.5 to L.3 inclusive and emerge in the corresponding anterior roots (*Gray's Anatomy*, 1942); the parasympathetic supply derives from the vagus and from sacral segments 2, 3 and 4. The object, therefore, is to paralyse the anterior roots of the spinal cord up to T.5 at least; the posterior roots will inevitably be paralysed too, but success of the injection should be gauged, not so much by the level of anæsthesia obtained, as by the signs of anterior root involvement—i.e., muscular paralysis and loss of tone over abdomen, intercostals, and legs, some fall in blood-pressure, and slowing of the pulse-rate.

Theoretically, the reagent used should not matter so long as the desiderata set out above are obtained, but in practice it has been found that one of them gives the desired result more certainly than any of the others used in this series of cases. Stovaine, Chaput's solution, was used in the early cases, but is now considered unsuitable on account of its toxicity and the fact that such a small total quantity is required—0·4–0·6 c.c., according to the size of the child—as to make accurate dosage impossible. Heavy percaine is contra-indicated for similar reasons. Decicaine was used in Telford's cases (personal communication) in dosages of 1 mg. of crystals per year age of child, and was used for one in this series, but it has to be dissolved in the patient's cerebrospinal fluid, and this adds a complication that need not be encountered. Light percaine 1–1500 is now used and found to be highly satisfactory. The solution has a specific gravity of 1·0036 as compared with that of cerebrospinal fluid 1·004–1·010, and therefore diffuses to whichever part of the cord is uppermost. This explains why the child is placed in the positions about to be described. The dosage is calculated *either* as 1 c.c. per year age of patient, *or* on the Howard Jones formula (designed originally for calculation in adults)

$$P = D - 6$$

whichever gives the smaller result; this precludes using too much in a puny child. P is the amount of percaine in c.c. and D is the distance in inches measured from the 7th cervical spine to the intercristal line with the back flexed.

The whole technique is as follows: no basal narcotic premedication is given, but ephedrine (gr. ¼) is given intramuscularly just beforehand. The percaine, warmed to blood heat, is injected into the space between the 2nd and 3rd lumbar vertebræ with the child sitting up, and it should take about fifteen to twenty seconds to inject the solution. If the child is difficult, and most of them are not if properly managed, a little ethyl chloride is given while the injection is being made and the child is sat up afterwards. The child remains sitting for twenty seconds, fifteen seconds in a child under 3 years, and is then placed on its back in the reversed Trendelenburg position, i.e., shoulders highest; this ensures that the bulk of the percaine will affect the anterior roots and will continue to travel upwards. This position is usually maintained for five minutes, or until the child complains of pins and needles in its hands; one case did so after two minutes, but this is unusually quick. The table is then tilted, bringing the shoulders downwards, thus ensuring that the percaine will not continue to ascend up the

cord and thereby menace the cervical region and paralyse the phrenic nerve. About twenty minutes or more is required before the full effect is noticed and the characteristic picture obtained; it lasts for about an hour and a half. The child appears paler than before, lies quietly, and becomes drowsy; one case became semiconscious but could just be roused. The legs, abdominal muscles, and thoracic muscles are paralysed and breathing is solely diaphragmatic. There is marked loss of tone in the abdominal muscles, which can be pressed right in and only slowly recover their previous position. The blood-pressure is raised before the injection by reason of the ephedrine, usually up to 130 mm. Hg or thereabouts systolic, and shows some fall, probably to 110 to 120 mm. If ephedrine is not given the drop is from normal to well below 100 mm.

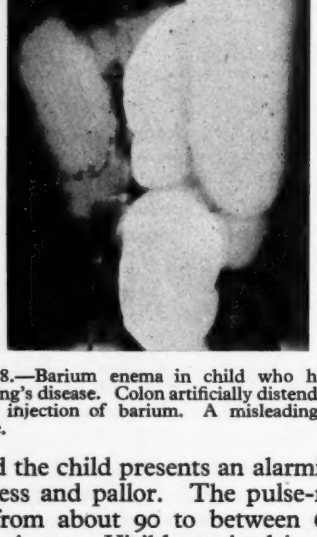


FIG. 208.—Barium enema in child who has *not* got Hirschsprung's disease. Colon artificially distended immediately after injection of barium. A misleading picture if taken alone.

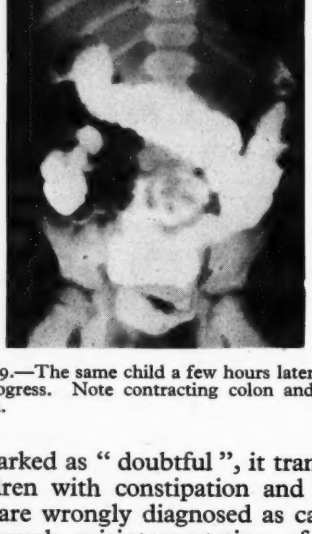


FIG. 209.—The same child a few hours later. Evacuation in progress. Note contracting colon and return of haustration.

systolic and the child presents an alarming picture of drowsiness and pallor. The pulse-rate slows, generally from about 90 to between 60 and 70 beats per minute. Visible peristalsis occurs and can be initiated by abdominal palpation. There is anæsthesia up to the nipple line or higher. Priapism, described by Court and Haslar (1942), has never occurred in this series. At this stage a rectal examination should be made, any fæces present removed manually, and an attempt made to feel the pelvirectal junction and assess its degree of spasm. If contracted it should be manually dilated. This is important; Telford (1939) states that the achalasia is more commonly at the pelvirectal junction than the anal sphincter, and *Case* 9, operated on at Ipswich, had a megacolon beginning at the pelvirectal junction (personal communication from Mr. Charles). *Cases* 7 and 9 showed the benefit of this manœuvre very clearly. Both were having marked peristalsis without effect until fæces were removed and the pelvirectal junction dilated; both then passed quantities of flatus with decrease in abdominal distension. It must once again be emphasized that even with the above result in the theatre no immediate improvement need necessarily ensue; *Case* 7 showed just as marked abdominal distension the next day as it did before the injection.

The after-treatment consists in washouts on alternate days if no spontaneous bowel action occurs, and liquid paraffin nightly. This regime is discontinued on returning home, with the proviso that a weekly enema may be necessary, depending on the severity of the case. *Cases* 2, 4, and 5 needed neither laxative nor enemata after a short while. *Cases* 1 and 3 still have small doses of liquid paraffin.

SOME PITFALLS IN THE DIAGNOSIS

From a perusal of cases diagnosed as Hirschsprung's disease or congenital megacolon, and of some marked as " doubtful ", it transpires that some children with constipation and abdominal distension are wrongly diagnosed as cases of this disease through misinterpretation of a barium enema. One such case illustrates this point: J. G., male, aged 6 years, attended two and a half years ago with severe constipation, bowels not being open for five days at a time. A radiograph showed a dilated colon, and he was diagnosed as a case of Hirschsprung's disease. A second film taken twenty-four hours later seems to have passed unnoticed by the physician; it showed a contracted colon with a few remnants of barium here and there and a moderate quantity in the rectum awaiting expulsion. In other words, the gut was probably atonic following a period of constipation and filled readily as the barium was poured in. Had the evacuation picture been examined the diagnosis could not have been made; as it was, however, a spinal anæsthetic was given and the case has, until now, been regarded as a cure. *Figs.* 208, 209 illustrate a similar condition in another child. X-ray diagnosis is best made by barium meal and

follow-through, a truer picture of the dilatation and slow emptying being obtained. A barium enema is liable to distend the gut unduly and is only reliable provided a second picture is taken twenty-four hours later to show the emptying power or otherwise of the gut.

Visible peristalsis is an important diagnostic feature, as appears from the case histories, and can occur at all ages. Eight cases showed this in a marked degree, 1 case (*Case* 5) did not have it, and 3 cases may or may not have shown this phenomenon; they were not seen originally by the writer and the point is not mentioned in the notes. Its presence does not depend on the age of the child or the length of time symptoms have been present, and it suggests that the sympathetic overaction is mainly centred on the achalasia part of the mechanism rather than on the inhibition of gut movements. The peristalsis seen after spinal anæsthetic is little greater than that seen beforehand.

It appears, then, that abdominal distension, constipation, and sometimes a spurious diarrhœa, and marked visible peristalsis, are the main important clinical features; X-ray evidence on one film of a barium enema is a pitfall to be guarded against.

DISCUSSION

It seems fair from a study of these 12 cases to take a hopeful view of the effect of spinal anæsthesia in Hirschsprung's disease. The two salient features that emerge and which cannot be over-emphasized, are that time must be allowed, and spinal anæsthesia must be repeated twice or three times before the case is judged to be unsuccessful. In several cases not included in this series on account of multiple methods of treatment, including spinal anæsthesia, and in two cases death of the child after operation, barely a month had been allowed in which to assess benefit or otherwise to the child; in all the cases described improvement has been slow in onset, but is none the less definite. Four weeks was the earliest in which definite improvement in the long run began and *Table* 1 shows significantly that the cured cases range from twelve months to two years and eight months after spinal anæsthesia, while the improving cases have as yet had no longer than four months since the last anæsthetic. These latter have each had two spinals so far; they will be seen periodically, and if improvement is not being maintained they will be re-admitted for a further spinal anæsthetic. I do not think operation will be considered in any of these cases; comparatively, spinal anæsthesia affords as good, and probably better, results than sympathectomy, which is so often disappointing in so far that the immediate improvement is not maintained. At least spinal anæsthesia should be given a trial and the case observed for many months before sympathectomy is considered, for often after six months or so all symptoms may have completely returned; *Case* 9 illustrates this. Furthermore, there is the risk of fatality in such severe operative procedures as colectomy.

It will be asked, how much of the success of treatment is due to adjuvants afterwards, liquid

Table I.—SUMMARY OF 12 CASES TREATED BY SPINAL ANÆSTHESIA

Case	Age		Time Elapsing before Spinal	Main Symptoms				Number of Spinals	Result	Time Since Spinal	X-ray Change
	Now	When Symptoms Developed		Distension	Constipation	Diarrhœa	Visible Peristalsis				
N. H.	8 yr.	2 yr.	3 yr.	+	+	0	Not known	1	Cured	3 yr.	None
2. D. W.	6 yr.	Birth	3 yr. 6 mth.	+	+	0	Not known	2	Cured	2 yr. 8 mth. and 2 yr. 7 mth.	Yes
3. B. H.	3 yr.	Birth	2 yr.	++	+	0	+	1	Cured	1 yr. 3 mth.	None
4. A. D.	3 yr. 6 mth.	2 yr. 3 mth.	3 mth.	+	0	+	+	1	Cured	1 yr.	Not obtainable
5. J. G.	6 yr. 6 mth.	5 yr.	10 mth.	+	0	+	0	3	Cured	1 yr.	Yes
6. A. S.	11 yr.	8 yr. 6 mth.	2 yr.	+++	+	+	++	2	Improving	7 mth. and 4 mth.	None
7. J. E.	5 yr.	Birth	5 yr.	++	+	0	+	2	Improving	5 mth. and 1 mth.	—
8. M. McF.	2 yr.	Birth	1 yr. 4 mth.	+	+	0	+	2	Improving	6 mth. and 1 mth.	—
9. W. S.	7 yr.	4 wk.	4 yr.	+++	+	+	+	2	No better	2 yr. 1 mth.	—
10. C. C.	10 yr.	5 wk.	2 yr.	++	+	0	Not known	1	Cured	1 yr. 5 mth.	Not obtainable
11. R. R.	2 yr.	Birth	2 yr.	++	+	0	+	1	Improving	2 mth.	—
12. C. S.	2 yr. 3 mth.	5 wk.	2 yr.	++	0	+	+	1	Improving	2 mth.	—

paraffin, enemata, and so on. The reply is that all these cases had had plenty of medical treatment beforehand without any real success. A child can be kept in a fair state of health by weekly washouts, but if these are abandoned the case relapses, the abdomen distends, and the bowels cease to function till the next washout, abdominal massage, or suppository. *Case* 7 exemplifies this. Liquid paraffin and enemata afterwards are treatments directed solely to preventing massive accumulation of fæces and mechanical obstruction. The histories show that most of the patients do not require to continue in this way. *Cases* 4 and 5 show this; *Case* 2 was to have had monthly evacuations, but this has never been necessary; and *Case* 10 requires no laxative if constipating medicines are withheld.

As regards the explanation of the results of spinal anæsthesia, I have no better suggestion to offer than that put forward by Telford and stated earlier on in this article. It seems difficult to understand why paralysis of an overacting portion of the nervous system should result in its subsequent return to function, or why time and repeated treatments should be required to make it do so. One can only place the results on record and hope that trials throughout the country will be made and the results made known. Finney (1908) has described fully the pathology of the disease, stating that there is hypertrophy of all coats and an increase of fibrous tissue. This increases with the age of the lesion and becomes gross and irrevocable, he says. I think that the success of the treatment must be influenced by how far the fibrotic process has gone, but time in itself need not be the guide; *Case* 10 had symptoms for eight years before spinal anæsthesia. In some patients this process may be a quick one, in others much slower, and a case should not be prejudged on time alone. It would seem that the more vigorous the peristalsis the more hopeful the case. Let spinal anæsthesia be tried, repeated, and ample time allowed.

In conclusion I wish to thank the medical committee of the Hospital for Sick Children, Great Ormond Street, for permission to describe these cases, and in particular Dr. W. G. Wyllie and Mr. Twistington Higgins for their constant help and encouragement. Also my thanks are due to Dr. C. W. Morris and Dr. Sheila Anderson for permission to include the results of the anæsthetics they gave, and to Dr. Donald Paterson, Sir Lancelot Barrington-Ward, and Dr. Ivor Magill for permission to describe their private case (*Case* 10).

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FRACTURES AND DISLOCATIONS OF THE CERVICAL SPINE*

BY F. CROOKS AND A. N. BIRKETT, NOTTINGHAM

IN this paper on cervical spine injuries no attempt will be made to give a full summary of the whole problem and the paper will be limited mainly to a review of a series of cases which have been under our observation at the Nottingham General Hospital and the Chesterfield Royal Hospital during the seven-year period ending Dec. 31, 1941.

The total number of cases under review is 59 and the incidence is as follows: at the Nottingham General Hospital there were 50 cases in a group of 368 cases of fracture of the spine out of a total number of 28,000 fractures seen at the clinic during the period under consideration; at the Chesterfield Royal Hospital there were 9 cases of cervical spine injury in a group of 250 spinal fractures out of a total number of 11,479 fractures seen during the same period.

The approximate incidence in industrial fracture clinic work appears to be 1 cervical spine injury to 600 general fractures. On analysis of the fractures of the spine at the Nottingham General Hospital it became evident that the relative frequency of injuries to different parts of the spine was roughly 1 cervical to 2 dorsal, and 1 cervical to 4 lumbar. We do not believe that this proportion of spinal fractures would hold in all hospitals in the country, for in the industrial area served by these two hospitals there is a large number of collieries, from which the majority of dorsal and lumbar spine fractures is received. It is apparent that there is a considerable difference in the proportion between the cervical spine injuries and the total number of fractures in the figures of the Nottingham and Chesterfield Hospitals. This fact is, perhaps, to some extent accounted for by the larger size of Nottingham as an industrial centre, and by the fact that Nottingham serves a larger rural area and more cases are referred to it from smaller hospitals.

* Read by A. N. Birkett at the meeting of the British Orthopædic Association at Nottingham, September, 1942.

It is not always possible to determine accurately the mechanism by which the cervical spine receives injury, as these accidents are sometimes of considerable violence, particularly in connexion with motor cars and motor cycles, and they happen too quickly for the victim to be able to relate his experiences. In consequence, classification in terms of type of violence is difficult and classification in terms of types of accidents more simple and useful.

TYPES OF ACCIDENTS

Table I gives the number of cases from certain types of accident, and the main facts which can be seen from it are, that industrial accidents, which include mining accidents and most of the falls from heights, form the largest group; road accidents come next in frequency, followed by domestic accidents. Sport is the cause of relatively few cases. Of the domestic accidents, falling down stairs accounts for a very high proportion. With regard to age, as would be expected in severe road accidents, all ages are represented; in industrial accidents most occurred in middle age; the domestic accidents occurred in middle-aged or elderly people; in young people, industrial accidents and sport were the main cause of cervical injuries.

Table I.—Types of Accident and Frequency

Types of Accidents	*Number*	*Remarks*
Road accidents	13	All age groups, 20–70 years
Falls downstairs	11	All over 30 years, and 7 over 50 years
Mining accidents	10	8 due to falls of coal or roof, and 7 of these were over 40 years
Falls from a height	6	All over 40 years
Diving accidents	4	All under 40 years, and 2 under 20 years
Simple falls	4	3 over 50 years
Falls of heavy object on head	3	Age group, 31–40
Caught in industrial machinery	1	Age 54 years
Thrown by bomb blast	1	Age 28 years
Fall in epileptic fit	1	Age 44 years
Cranking a heavy lorry	1	Age 37 years
Shovelling dirt	1	Age 44 years
Blow in the back	1	Age 56 years
Fall from horse	2	Age 22–23 years
Total	59	

CLASSIFICATION OF CASES AS GROUPED IN TABLE II

The cases under review have been classified in the groups tabulated in *Table II*. In some cases double fractures have occurred and these cases have been included only under the main lesion.

Group 1. Spinous Process Fractures.—One class of fracture can immediately be isolated and dealt with as a definite entity, and this is the spinous process fracture occurring in the lower part of the cervical spine and perhaps associated with fractures of the 1st and 2nd dorsal processes. They are unrelated to fracture-dislocation of the neck and have been described by McKellar Hall (1940) under the name of clay-shoveller's fracture.

There were 6 cases of fracture of the spinous process alone out of 59 cases. They were all fractures either of the spinous process of the 6th or 7th cervical vertebra, or both, or associated with the 1st dorsal vertebra. A typical example of this type of case occurred in a man, aged 37 years, who was presented with the problem of starting an obstinate and unresponsive lorry engine. He wound and wound at the starting handle, and finally retired defeated and conscious

Table II.—Grouping of Fractures and Dislocations of the Cervical Spine

Groups			*No. of Cases*
1	Spinous Process Fractures Alone		6
2	Transverse Process Fractures		1
3	Fractures of the Main Vertebral Substance and Fracture-dislocations and Dislocations :—		
	a. Fractures of the atlas (main feature)	3	53
	b. Displacements of atlas on axis	4	
	c. Fracture of the odontoid process	2	
	d. Fractures of the axis and displacement on C3.	6	
	e. Compression fractures at all other levels	7	
	f. Fracture-dislocations at all other levels :—		
	i. Displacements and subluxations with disc injuries	10	
	ii. Displacements with locked facets	8	
	g. Injury to pathological spines :—		
	i. Spondylitis osteo-arthritica	11	
	ii. Ankylosing spondylitis	2	

of a pain in the neck. He had fractures of the 6th and 7th spinous processes. He was treated in a plaster collar and made a good recovery. A similar case arose in a man of 44 years who felt a crack in his neck while shovelling some dirt. He had a fracture of the 7th spinous process. The other four cases did not give such clear clinical histories, but seemed to be due to either muscle effort or direct violence, in one case to a blow by a plank.

Of these 6 cases, 3 made full and symptomless recoveries. In 2 cases the diagnosis was only made late, when they attended a long time after the accidents. They complained of chronic pain in the neck and had had no treatment. The sixth case, a young jockey, cannot be traced, but it may be assumed with fair confidence that he made a good recovery.

Considering the possible lines of treatment it is noted that fixation in a plaster collar and early excision of the fractured process are both equally effective, but it is clear that excision of an isolated spinous process fracture is the quicker method of aiding recovery, while if two or more spinous processes are fractured, fixation in plaster is possibly the better line of treatment.

Fractures of this type are not likely to be found above the level of the 6th cervical as they are due either to direct violence or to muscle pull on fairly long processes of bone, and above the level of the 6th cervical the bony processes become considerably diminished in size and the strain imposed upon them becomes cushioned on the ligamentum nuchæ. Thus spinous process fractures above the level of the 6th cervical vertebra are more likely to be part of a fracture-dislocation of the neck.

Group 2. Transverse Process Fracture.—In all cases under review there was only one definite fracture of a transverse process to be seen and this was incidental in a man who suffered severe injuries from which he died. This was a fracture of the 7th cervical transverse process and was due to either muscular or direct violence.

Group 3. Fractures of the Main Vertebral Substance and Fracture-dislocations and Dislocations.—In this group division into sub-groups having common features was not easy and our grouping was chosen after taking into account anatomical facts, and a consideration of treatment, prognosis, and the existence or otherwise of any pre-existing pathology in the vertebral column. Congenital abnormality did not appear to be a factor in any of these injuries.

Two graphic representations of the group of fracture-dislocations are of interest; first, the grouping of cases with regard to the level of the lesion. This has been done in *Fig.* 210, each group comprising fractures of the vertebral body, and displacement of the same vertebral body on the one below, or either of these features if occurring alone; thus the atlas and odontoid are grouped together with displacement of the atlas on the axis, and fracture of the body of the axis and of the laminæ of the axis are grouped with displacement of this bone on the 3rd cervical vertebra, and the other levels fall into place below. In each group four columns have been used, the first column representing the total number of cases, the second column the number of deaths, the third column the number of paraplegias, and the fourth column the number of pathological spines with fractures or dislocations. Grouping the cases in this way shows

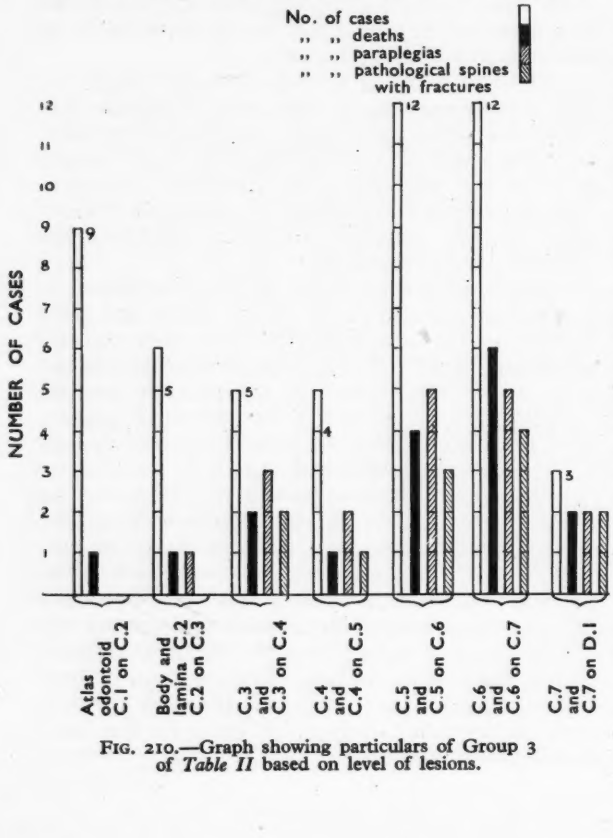

No. of cases
,, ,, deaths
,, ,, paraplegias
,, ,, pathological spines with fractures
NUMBER OF CASES
Atlas odontoid C.1 on C.2
Body and lamina C.2 on C.3
C.3 and C.3 on C.4
C.4 and C.4 on C.5
C.5 and C.5 on C.6
C.6 and C.6 on C.7
C.7 and C.7 on D.1

FIG. 210.—Graph showing particulars of Group 3 of *Table II* based on level of lesions.

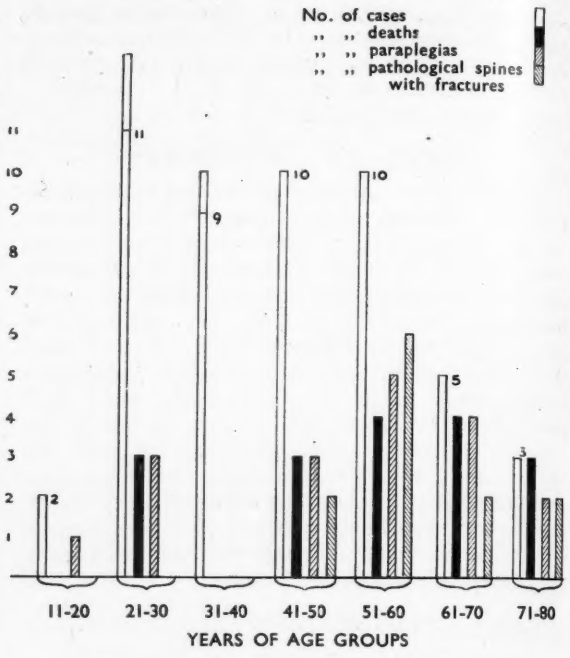


FIG. 211.—Graph showing particulars of Group 3 of *Table II* based on age groups.

that the bulk of the injuries are in relation either to the 1st and 2nd cervical vertebræ or in relation to the 5th and 6th cervical vertebræ, including displacement of the 6th on the 7th. It is seen also that the injuries to the atlas, axis, and odontoid have a comparatively low mortality and that the proportion of deaths rises steadily as the injuries are followed down to the 7th cervical vertebra. The paraplegia rate and the death-rate are almost parallel and the pathological features of the spine come into evidence in the lesions lying below the level of the 4th cervical vertebra.

The second graphic representation is in age groups (*Fig.* 211). Ten-year age groups have been taken starting with 11 to 20, 21 to 30, etc., up to 80 years. As before, the number of cases has been represented in four columns; the first being the number of cases, the second the number of deaths, the third the number of paraplegias, and the fourth the number of pathological spines with fracture or dislocation. This diagram shows that few cases occur in youth. From 21 to 60 years the groups are almost equal in number. There appears to be a rising mortality as age increases. This rising mortality rate is roughly parallel to the paraplegia rate. Pathological spines, which are chiefly arthritic, make their appearance after 41 years of age. It shows that up to 60 years of age the incidence of fatal cases is under 1 in 4, while after 60 years of age, 7 out of 8 cases died.

ANALYSIS OF FRACTURES IN GROUP 3

Fractures of the Atlas.—There were 3 cases of fracture of the atlas; all were of the same type, fracture of the posterior arch of the atlas; they conform to the burst fracture of the atlas ring which occurs when a force is put on the skull and transmitted through the lateral masses of the atlas to the axis. This type of fracture was described in detail by Jefferson (1920). These were isolated fractures; one further case occurred, associated with fracture of the axis and 3rd cervical vertebra.

One interesting case was that of a man of 34 years of age who hurt his head while diving into a swimming bath. He is quite certain that he did not hit his head on the bottom of the bath, but twisted his head while diving into about 8 ft. of water, and it seems possible that muscle violence may have taken some part in the causation of the fracture. X-ray examination showed a fracture of the posterior arch of the atlas, which was easily seen in the lateral view, while the antero-posterior view showed spreading of the articular masses of the atlas over and beyond the articular facets of the axis. The man is a miner and returned to full-time work at the coal-face. In the second case, the injury was caused by the fall of a painter's trestle on a man's head. He made a full recovery and is now in the R.A.F. as an A.C.1 (traced two and a half years after accident). The third case, a middle-aged woman, fell downstairs. She has made a complete recovery. X-ray evidence shows that the union of this type of fracture takes place readily.

In no case was there any gross injury to the spinal cord. Treatment was carried out by simple fixation in a plaster collar for a period of two to three months.

Displacement of the Atlas on the Axis.—There were two cases of this injury. One was a boy of 21 years of age, who was injured in a motor-cycle accident and who received a unilateral dislocation of the atlas on the axis. This was reduced under an anæsthetic and then splinted in plaster, and now, seven years after his accident, he says that he has slight pain at times, particularly on rotation of the head sideways. He is able to do his normal work as a shop assistant without difficulty.

The other case was that of a man of 72 who fell downstairs. In spite of gross displacement of the two bones in relation to each other and fracture of the odontoid, there was no gross paraplegia. He was able to move his arms and legs, but did complain of some paræsthesia of the arms. He died of hypostatic pneumonia; his age was largely responsible for his death.

FIG. 212.—Fracture of odontoid with displacement.

FIG. 213.—Same case, after two years.

Fracture of the Odontoid.—Apart from the case mentioned above, 4 cases of fracture of the odontoid occurred, all due to severe violence such as motor-cycle accidents, falls from heights, etc.; in each case there was displacement—in 3 cases the displacement was forwards, in 1 case it was backwards.

The type of displacement in one case is shown in *Fig.* 212. This is a man of 37 years of age

who was injured in a motor-cycle accident. Radiograph taken two years after the accident (*Fig.* 213) showed good union, and he says that he is doing full-time work in a munition factory.

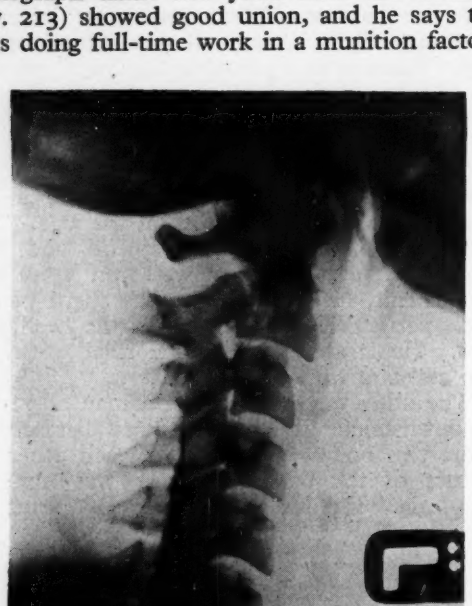


FIG. 214.—Fracture of lamina of axis with displacement of body forwards.

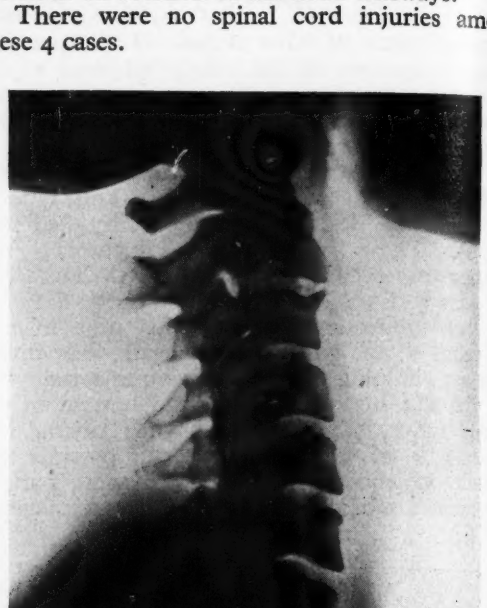
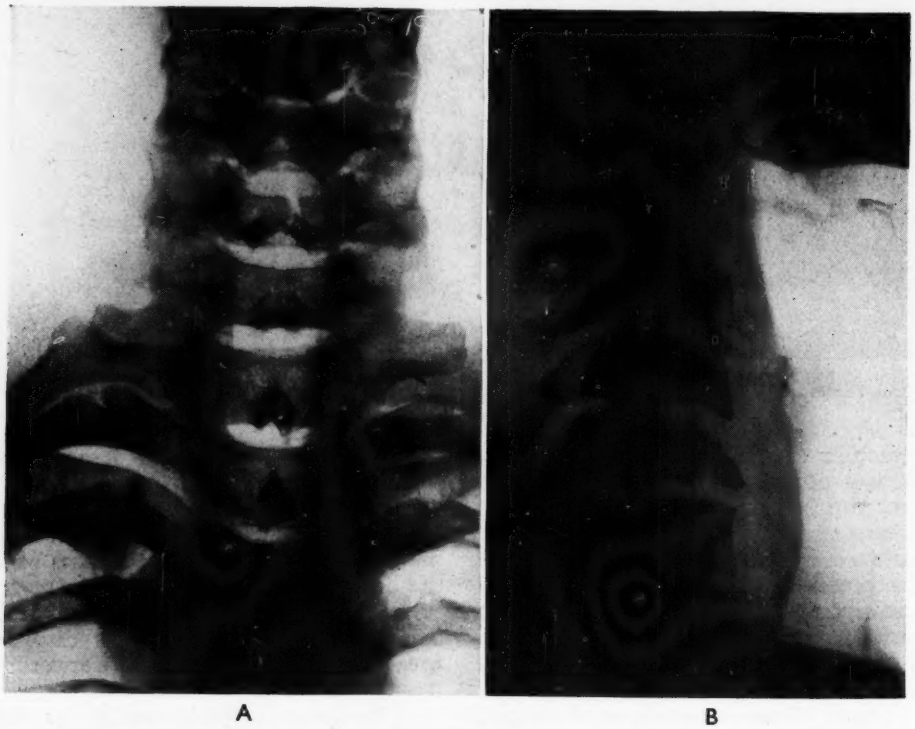


FIG. 215.—Same case, after two years.

Examination showed that he had full movements of the neck except for slight restriction on rotation of the head. He had little or no pain. The other 3 cases made good recoveries. The only complaint made was that of some discomfort of the neck on rotation of the head sideways.

There were no spinal cord injuries among these 4 cases.

Fractures of the Axis and Displacement of the 3rd Cervical Vertebra.—Apart from fracture of the odontoid, the axis was fractured or displaced on the 3rd cervical vertebra in 6 cases.



A B

FIG. 216.—Compression fracture C.6. A, Anteroposterior view, showing vertical split; B, Lateral view.

Consideration of the facts led us to group these cases together.

The anatomical structure at this level of the vertebral column is unique. The weight of the skull is carried on the lateral masses of the atlas and transmitted down to the axis on to the upper articular surfaces on either side of and in the same coronal plane as the odontoid, and in line with the vertebral bodies. Thus, the weight is carried in front of the lower articular facets of the axis. The axis is supported in front by the disc below its body, and behind by the relatively horizontal articular facets between its articular processes and those of the 3rd vertebra. A characteristic of the axis vertebra is that it has the only large and strong lamina and spinous process in the upper cervical region, and has strong muscle attachments, receiving the semi-spinalis colli and the multifidus spinæ muscles from below. In consequence, the sudden weight of the head, acting through the lateral masses of the atlas, falls anteriorly and may cause flexion of the neck and a glide of the axis forwards. The axis may subluxate on the 3rd cervical vertebra or the strong group of posterior muscles may

FIG. 217.—Same case, after five years.

fracture the lamina, or both may happen. It might almost be said that the bone may be broken over the wedge of the articulation with the 3rd cervical vertebra, much in the manner of an osteoclasis, by the downward force of the skull at the front and the downward pull of muscles on the spinous process behind. An example is shown in *Fig.* 214. The patient was a woman of 42 years of age, who was injured in a motor-cycle accident. She was treated in a plaster collar. Union of the fractured lamina took place readily, and two years after her accident she had practically no pain, full movements of the neck, and was doing all her pre-accident work. *Fig.* 215 shows the radiograph taken two years after the accident, showing firm union with persistent subluxation and evidence of buttressing of the 3rd cervical vertebra.

Consideration of the anatomy again shows that any forced hyperextension at this level must be over the wedge of the articulation with the 3rd cervical vertebra and if the force was great, after fracture of the body or tearing of the ligaments, backward displacement was possible. An example of this type of fracture showed marked displacement of the axis backwards with fracture of the lower margin of the body of the vertebra, which had remained in place through its attachment to the anterior common ligament below. He was a man of 25 years of age. There was no cord injury and after five years he states that his neck is completely normal and causes him no trouble whatsoever.

Of the 6 cases in this group, 2 had displacement of the axis backwards, 2 displacement of the axis forwards, 2 had fracture of the lamina with only slight or no displacement of the bones.

Of these cases only 1 case, a woman of 65 years of age, had any injury to the spinal cord. This appears to have been of the nature of hæmorrhage, for she had an easily recognizable Brown-Séquard syndrome, and she died of respiratory complications after one month. She had fallen downstairs and the displacement was backwards and associated with fracture of the posterior arch of the atlas.

With regard to the other cases, during the course of treatment and after-care it was noted that 1 case developed a fusion of the bodies of the 2nd and 3rd cervical vertebræ, 1 developed marked buttressing of the lower body, and that all the fractures had united. The ultimate function of the 5 cases which recovered was excellent.

Compression Fractures at all Other Levels.—There were 7 cases of more or less pure compression fracture, and these were all between the ages of 15 and 43 years. The accidents causing the injury were all fairly severe, such as diving into swimming baths, falls from a height, or weights dropped on to the head. Two of these cases had associated fractures of spinous processes. There were no cases of cord or root injury.

A typical case was that of a boy of 15 years of age who dived into a swimming pool and hit his head on the bottom of the pool. X-ray examination showed that he had a compression fracture of the 6th cervical vertebra with easily recognizable wedging and fracture of the anterior part of the body. Reduction was accomplished by head traction, and later a plaster collar was

applied. On examination a year after the accident he had made a full and symptomless recovery and no evidence of fracture or growth defect could be seen.

Fig. 216 shows a more severe type of compression fracture which includes a vertical split of the fractured body. This patient was a man

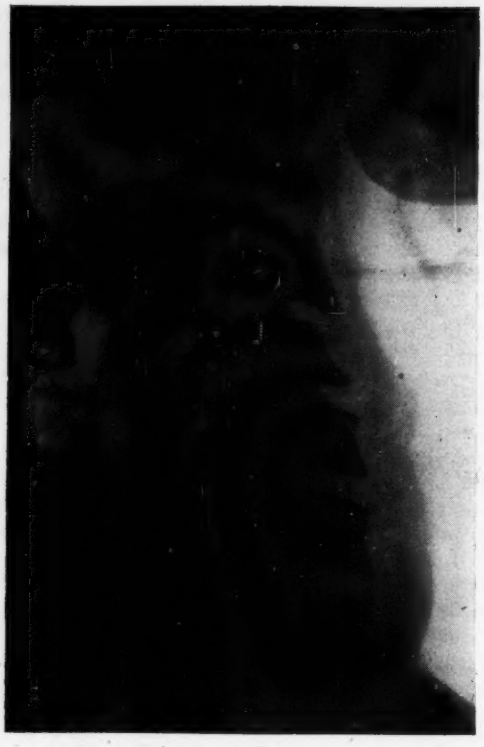


FIG. 218.—Fracture-dislocation C.3 on C.4 and C.4 on C.5.

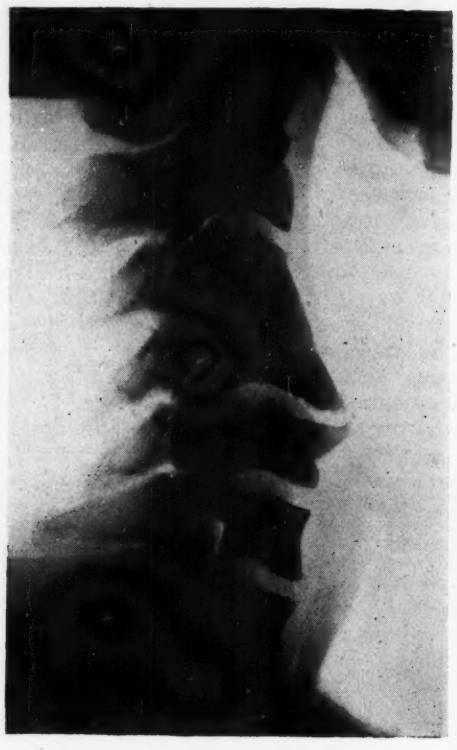


FIG. 219.—Same case, after five years.

of 23 who dived into shallow water when he was off his balance. He was treated by head traction and plaster collar and returned to work as a miner; he has, however, been doing only light work since the accident, although after five years he gets very little pain or discomfort (*Fig.* 217).

Study of compression fractures leads one to the following conclusions: the prognosis and recovery are excellent; successful reduction restores normal vertebral contour; and the intervertebral discs are not affected.

There is danger of the diagnosis being missed as the pain may be only slight. One of the cases examined did not report to hospital for sixteen days, and another completed his holiday at the seaside before attending hospital.

Fracture-dislocations and Subluxations.—In this group of 10 cases, fracture, if present, was not the major part of the injury. The lasting injury was done to the soft tissues, the intervertebral discs, ligaments, joints, and muscles. It is extremely dangerous to call them, on X-ray evidence, subluxations. The following case will serve to illustrate this point (*Fig.* 218).

A boy 20 years of age, who was in the Navy, while on leave in Nottingham went to the local baths with a friend and in the course of his visit he made one dive from the 10-ft. board too steeply so that his head hit the bottom of the bath. In hospital, he said that he knew he had hurt himself and swam to the side of the bath and climbed the steps, and then got his pal to look at the top of his head to see if there was a cut. As he bent to be examined, he felt a queer pain in his neck. He had a small cut on the back of the head and walked some 15 yd. to the attendant's hut to ask for treatment. While the attendant was cutting the hair round the small wound and the boy was smoking a cigarette, quite suddenly he felt the strength go out of his arms. He tried to stand and fell forward and was caught by the attendant. He felt no pain until he was down on his back on the floor and someone tried to put a small pillow under his head. The attendant found that he could not feel in his arms or legs, or his trunk, so had him brought direct to the hospital on a stretcher. On examination in the Casualty Department he was found pale, shocked and cold, and he complained of pain in the neck. He had no perception of sensation from the 6th cervical downwards and his limbs and trunk were correspondingly paralysed. He was taken to the ward and traction applied by means of a head halter; this eased the pain in the neck. The extent of the paralysis was re-checked and he was left under a radiant heat cradle. About fifteen minutes later, one of

us (A.N.B.) spoke to him again and he complained of something pressing on his right hand. This was found to be the side of the radiant heat cradle. He was immediately re-examined and it was clear that there was complete recovery of function of the spinal cord.

This boy must have had a slow, gradual, pressure on the spinal cord due to slow displacement of the vertebra and not to the initial violence. Correction of this brought rapid recovery.

The X-ray film could, with some justice, have been regarded as showing only subluxation, though his case history shows that there must have been fairly complete displacement to allow spinal-cord compression.

He was up and about in a plaster collar after a few days and had made a full recovery from his nerve injury. He returned to the care of the Navy after four months. We recently wrote to him, five years after his injury, asking if he had any trouble with his neck and received a reply after much delay. The obvious reason for the delay was that our letter had been forwarded to his ship, which was on active service. He said that his neck was now just as normal and as good

FIG. 220.—Fracture-dislocation of C.6 on C.7.

as before the accident. He never had any pain or stiffness in his neck and was not aware of any weakness, paralysis, pain, or stiffness in his arms or legs. He said he was able to carry out his duties as a Leading Stoker with enjoyment, and that he took part in all ordinary branches of sport. He had had some lively experiences in the course of his duties, and these had had no effect on him. Since these words were written he returned on leave, healthy, cheerful, and in every way strong. He said that he never had any trouble with the neck or with his limbs. He managed all work given to him and besides this took part in all sport, including boxing. His present X-ray condition is shown in *Fig.* 219.

Another case illustrating the need for care in diagnosis was that of a miner aged 33, who had been injured by a fall of coal on his head. He was brought into hospital with pain in his neck and tingling down both arms. X-ray films failed to reveal any serious cervical displacement or fracture, but suggested possible mild compression of the 6th cervical and subluxation on the 7th cervical. A radiograph (*Fig.* 220) taken some months afterwards showed attempted synostosis between the 6th and 7th cervical vertebræ, with marked narrowing of the intervertebral disc, demonstrating that considerable local injury must have taken place. *Fig.* 221 shows the bony changes after five years. This man, five years after his injury, still complains of some pain down his arms and slight restriction of neck movement. He is, however, in service with the Army, and able to do his duties.

The 10 cases in this group were all between the ages of 20 and 61. One died with complete

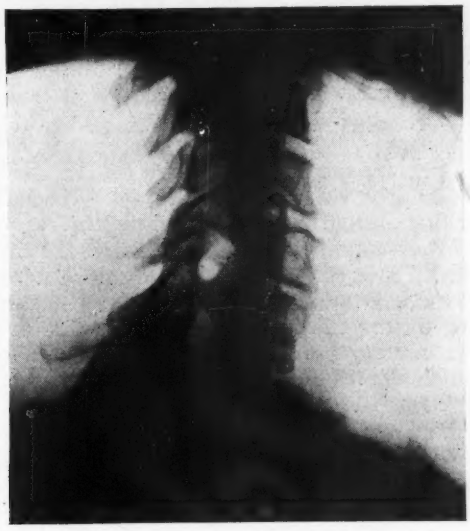


FIG. 221.—Same case, after five years.

paraplegia. Nine made a reasonable recovery. In all the cases the violence was considerable. For example, 4 were miners, injured by falling coal, 2 were road accident cases, 1 was a diving accident, 2 were due to blows on the head, and 1 a fall downstairs. Viewing the pathological changes resulting from this type of injury, we came to the conclusion that in general the changes developing were either synostosis of the adjacent vertebral borders, or a narrowing of the disc space associated with progressive lipping or buttressing of the anterior edge of the vertebræ. It is

probable that synostosis follows the more serious displacements.

The functional result in the 8 cases which could be traced was good and movement of the cervical spine was free or only slightly restricted. Five of the 10 complained of some degree of persistent pain in the neck, and 2, who had had some nerve-root lesions at the onset, still complained of some pain in the arms after several years. Of the five miners, none have returned to coal-face work, but are doing lighter work on the surface. One labourer returned to full work, including shovelling and all manner of rough jobs.

FIG. 222.—Fracture dislocation C.5 on C.6 after nine weeks.

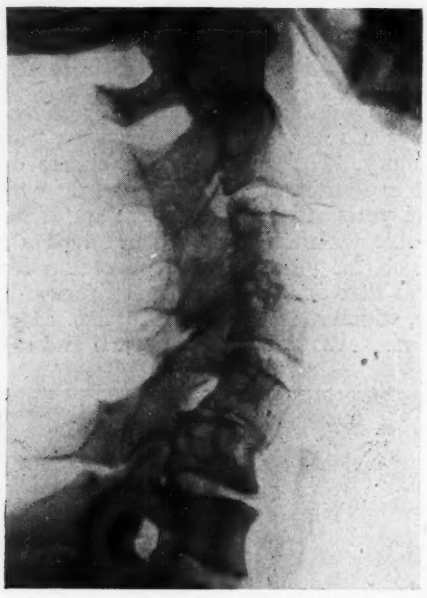


FIG. 223.—Same case, after six years.

In the study of a clinical condition it is always a point of interest to be able to consider in one's mind the effect that treatment has on the clinical course of the disease or injury, but it is not always easy to be able to find records of cases in which the treatment has been incomplete or insufficient. With regard to the treatment of the condition we have now under discussion, i.e. dislocations and subluxations, it is worth spending a moment or two considering what happens to these cases if the treatment does not come up to the standard one likes to set oneself. The 2 cases we are about to describe show very well that lack of surgical treatment does not necessarily give rise to bad clinical results.

Fig. 222 shows the radiograph of a miner, aged 51 years, who was struck on the back of the neck by a fall of coal. He first attended hospital after nine weeks, and as was to be expected, after this delay, full reduction was not obtained, and with some deformity still present, he was immobilized in a plaster collar. After four months, X rays showed early evidence of fusion of the injured bones. When seen six years after his accident he had almost full movement of his cervical spine (*Fig.* 223). He made complaint of some pain in his neck and right upper arm, but this did not appear to be severe, and he was in continuous employment engaged in light work.

An example of insufficient treatment is that of a man of 35 years who had an evening out, and on the way home disagreed with his two companions. In the ensuing discussion they dealt with him, presumably adding to their argument of words some convincing blows of the fist, and left him in a field for the night. He was found in the morning still under the influence of alcohol, but with an incomplete paralysis of his arms and a fracture-dislocation of the 4th cervical on the 5th cervical vertebra (*Fig.* 224). This man had an incomplete paraplegia as shown by temporary upset of bladder control and impaired sensation and movement of both hands. X rays showed that reduction of the neck deformity under traction was complete. Plaster splintage was carried out. As he was a very headstrong and self-willed fellow, he had the remnants of his plaster collar removed between the second and third months, and X rays showed further displacement. Some protection of the neck was continued with a Jones collar which he may have worn. He made an uneventful recovery from the injury to his spinal cord, and returned to do full work in a factory. Study of radiographs taken after nine months (*Fig.* 225) gave cause for considerable apprehension; however, it was not necessary to make any great decision on how to strengthen his neck, as he ceased attending hospital of his own accord, and as he had not been seen for two and a half years a letter was sent to him recently, asking him six questions about his present condition. A reply was obtained, not from him, but from his mother:

"In answer to your letter about my son, I am pleased to tell you that he is in the R.A.F. and he is fit, he has been in since he had done coming to the Hospital he passed A.1. he did not tell them about 'is accident and we dont know 'is present address now as he only went overseas last week but as soon as we get to know where he is gone I will send your letter to him and let you know I think him being passed A.1 answers the six questions, when he 'as been home on leave he has always told me he is fit and feeling fine and he looks fit. Thanking you at the Hospital for making him fit again I think it was a wonderful cure. Yours truly, ——." We can certainly endorse the statement that it was a wonderful cure, but can give no personal observations of his recent condition. But it does appear that he must have a very good function of his cervical spine as he must have gained a sense of stability and well-being to allow him to enjoy his service life, and of course he must have passed several medical examinations without comment being made.

FIG. 224.—Fracture-dislocation C.4 on C.5.

FIG. 225.—Same case, after nine months.

Dislocation with Locking Facets.—There can be no possibility of overlooking the seriousness of this class of case, for the displacement is gross and the deformity of the cervical spine such that the patient is bound to be conscious that all is not well. Few have no injury to the spinal cord. The lesion in these cases is obvious and they have been classed together as reduction of the deformity presents a special problem. The lie of the facets holds the deformity, which can only be unlocked by powerful traction to overcome the overlapping and then replacement of the vertebræ in their normal position. From our experience in these cases we believe that the simplest and safest way to obtain reduction is by traction of the neck by halter and counter-traction on the legs by assistants while evipan or pentothal is given intravenously; the surgeon holds the neck in his hands and eases the reduction by gentle manipulation. In this way the reduction may be obtained quite early after the accident and reduction in some cases may be felt to take place by the surgeon carrying out the manipulation. Check radiographs taken immediately confirm the reduction, following which only a small amount of cervical traction is necessary in recumbency to maintain the position. Cases so conducted can be dealt with without recourse to the use of the skull calliper. The use of this calliper is in our opinion, however, necessary in cases which come for treatment after some days' delay. We cannot advocate that calliper traction is necessary in all cases and we do not feel that it is the best treatment in every case.

Eight cases in the present series came under this heading. Their ages ranged from 22 to 65 years; of these 6 died, 5 of which suffered from complete paraplegia from the onset. Two of these cases came to hospital two weeks after their accidents and one of them died of hypostatic pneumonia, while the other case of late attendance presented an interesting history. He was a soldier in France in the summer of 1940 and in the midst of the chaos of those summer months he was knocked down by a motor lorry and admitted to a hospital with a neck injury. He was in the hospital for a few days, during which time

rumours of impending events were being spread far and wide and, fearing being taken prisoner, he refused to stay in hospital for treatment and so lost all the privileges of an injured man. He hitch-hiked across France by lorry, literally holding his head in his hands, and as an ordinary Tommy waited his turn to be shipped across to England. He arrived in Nottingham, saw his wife, and attended hospital and was admitted all on the same day—this was eleven days after the accident. Radiographs taken then showed that he had displacement of the 5th cervical on the 6th cervical and he complained of root pains referred over both shoulders and deltoids (*Fig.* 226). Because of the delay in treatment it was decided to carry out traction by the use of Blackburn's skull calliper. Continuous traction was applied with increasing weights, and on the thirteenth day reduction was carried out under evipan. Full reduction was accomplished and the bones appeared to be in a perfectly normal position; this was maintained by reduced traction in recumbency for two to three weeks. He returned into the Army in May, 1941, but has since been discharged—not entirely on account of physical reasons. *Fig.* 227, taken two and a half years after the accident, shows that fusion has taken place between the anterior aspect of the affected vertebral bodies. He is now in quite good general health, but has slight limitation of movement of the neck at times, and pain referred over both shoulders. He is certainly fit to carry on a normal life.

FIG. 226.—Fracture-dislocation with locking of facets, C.5 on C.6, at eleven days.

FIG. 227.—Same case, after two and a half years.

The other case that recovered was that of a woman of 55 years of age who fell downstairs and had displacement of the 3rd cervical on the 4th cervical. Reduction was accomplished without difficulty and there was no definite paraplegia. No detailed after-history is available, but it appears that she made a good recovery from the injury to her neck, but has since died from an unassociated disease.

One of the fatal cases ought not to have died as he had no paraplegia. He did not come to hospital until two weeks after the accident, having suffered considerably at home, lying in severe pain which was referred down his arms. His general condition was poor. Reduction was accomplished under general anæsthesia, which may have contributed to a terminal pneumonia.

After survey of this class of case certain points appear to call for special comment; they should receive early treatment, for even if life is not lost by delay, root pain may become very intractable; a high mortality rate appears inevitable and is due to the initial spinal cord injury; paraplegia is not inevitable, but there is a tendency to injury of the nerve-roots. In cases where the spinal cord is not injured, good recovery can be expected after reposition of the injured vertebræ, and synostosis between the vertebræ is likely to take place and indeed it is to be hoped for.

Injuries to Pathological Spines.—The final sub-section of the classification shown in *Table II* is that of injury to the pathological spine. These cases, which number 12 in all, have been put in this group and not included in any of the previous groups for the simple reason that it seems that the degree of pathology in the spine would be likely to be accompanied by some

limitation of mobility of the spine and loss of elasticity, and it is thought that the bony changes present in the neck must have rendered the patient more vulnerable to injury. It is obvious that the majority of these cases could be put into the subdivisions already described, but some interest in the clinical points would be lost by doing so.

Ten of the cases showed bony changes usually described as spondylitis osteo-arthritica, and in these, with some confidence, one could assume that the necks, though not necessarily painful, were already stiffened by disease. The other 2 were completely ankylosed as part of a general ankylosing spondylitis. It seems clear that stiffness of the spine, and particularly of the cervical spine, in a sudden accident, either by falling or by something falling on the head, would diminish the chances of avoidance of severe strain on the vertebral column—in other words, it would lessen the chance of getting out of the way. It would have been of great interest if it had been possible to divide these cases into flexion injuries and hyperextension injuries, but clear accounts of the accidents could not be obtained, so no definite statements can be made. From consideration of these cases it seems probable that some at least of these accidents are due to hyperextension of the neck and that injury due to hyperextension is more likely to take place in a stiffened neck.

1. *Spondylitis Osteo-arthritica.*—There were 10 cases in this group, having bony changes sufficiently marked in all to assume that they would have effect on the influence of trauma. The ages were from 42 to 75 years, and although the cause of the spinal disease was not manifest in every case, in the main they were heavy manual workers such as blacksmiths, miners, farmers; 1 was an epileptic in the course of whose life many falls had occurred. The vertebral bodies were in general large, due to osteophytic outgrowths, and the substance of the bodies denser and more sclerotic. A similar change could be seen in the articular processes in some cases. In these accidents violence was usually severe; for example, 5 were due to weights falling on the head, 2 were due to falls downstairs, 1 to a fall from a cycle, 1 to a fall in an epileptic fit, 2 cases were of other types of fall.

One striking point in this group of cases is that only two of the cases showed any gross displacement of the bones; indeed, in some, the radiologist, unfamiliar with the clinical picture, reported no lesion except arthritic changes; yet there were 8 cases of complete or incomplete paraplegia and 6 of them died, out of a total number of 10 cases. The explanation of this was sought on two occasions at post-mortem examinations, and it was found that in spite of the X-ray films failing to demonstrate a lesion, in both cases a torn disc and torn ligaments were present, allowing fairly complete abnormal displacement of the bones. One case was at the level of the 4th cervical on the 5th cervical, and the other (*Fig.* 228) at the level of the 3rd cervical on the 4th cervical. In both cases, on post-mortem examination, hæmorrhage was found in

FIG. 228.—Fracture-dislocation of C.3 on C.4. Arthritic changes.

the spinal cord at the level of the lesion. It seems reasonable to suppose that these cases had been injured by hyperextension of a stiffened arthritic spine, and it is probable that due to the pathology of the vertebral column full displacement was prevented and the bones tended to replace after the striking force was removed. The lost elasticity of the neck may predispose to allow injury of the cord by pressure or hæmorrhage, by traction of the cord, or by root traction. Whatever the explanation, it is quite clear that in this type of case injury to the spinal cord is common.

These cases are difficult from the radiological point of view, for apart from muscle spasm the necks tend to be stiff and are difficult to X-ray, so diagnosis has to be made largely on clinical grounds. The level of the injury may be determined alone by the level of the lesion of the spinal cord, but may be helped by X-ray evidence of co-existing fracture of an isolated spinous process.

2. *Ankylosing Spondylitis.*—Two examples occurred of fracture of the cervical spine in men suffering from the late stages of ankylosing spondylitis. In both, the disease had progressed to complete fixation of the vertebral column. One, a man of 55 years of age (*Fig.* 229), fell downstairs. He was admitted suffering from complete paraplegia from the 5th cervical segment downwards. X rays showed a crack through the ossified intervertebral region between the 3rd cervical and the 4th cervical, but there was no displacement of the bones. It seems probable

that owing to stiffness of the spine, forced hyperextension caused a fracture of the ossified anterior ligament and intervertebral substance and caused injury to the cord. He died on the second day after his injury. This example showed clearly how vulnerable the spinal cord can be, even if there is no gross displacement evident when the patient is examined.

FIG. 229.—Ankylosing spondylitis with fracture through region of disc C.3–4.

The other case was a man of 72 years of age, who for the last forty years of his life had suffered from chronic rheumatism. He had remained at work and was a man eminent in his profession. He had to attend a scientific meeting of national importance in Nottingham and boarded a motor coach, with his wife, in Leeds. The coach moved as he was getting in, and he slipped, falling forwards and striking the right side of his neck against one of the bus seats. He was helped up and put on a seat and remained in this position throughout the journey to Nottingham. The journey was a strain on him and he was helped by doses of whisky and aspirin. When the bus stopped in Nottingham it was found that he was unable to rise from his seat and that his legs were paralysed. He was brought to the General Hospital suffering from complete paraplegia from the level of the 7th cervical downwards. Radiography showed that his spine, from the axis to the sacrum, was in one piece and that this was severed completely through the 7th cervical body and the upper portion displaced forwards on the 1st dorsal vertebra. He died in hospital after three days. X-ray examination revealed that the displacement of the bones was gross, so that it is probable that he had complete paraplegia from the time of the fall and that because of the stiff poker back and the rigidity of the thorax, he remained propped up in his seat throughout the journey to Nottingham, the seriousness of his condition becoming manifest only when he tried to stand up. As he was seen lying in bed, the rigidity of the thorax made the diaphragmatic action, which was his sole means of respiration, very much more efficient than is normally seen in paraplegic patients.

We have made no effort to describe the incidence of cases of multiple fractures, though these were found in a small proportion of cases; for example, the atlas and axis injured in the same case, a fracture of the odontoid process found with mild compression of the 3rd cervical vertebra. There is little to be gained by any detailed consideration of these multiple fractures except to make a note that they were considered under the heading of the more serious lesion.

COMMENTS

Causes of Death.—Of the 59 cases, there were 18 deaths, and the causes of death were four: (1) Initial violence with injury to the spinal cord, the lesion being clinically complete in 13 cases and incomplete in 2. (2) Shock, associated with old age—this was held to account for the death of the man of 72; the physical injury would probably not have caused death in a younger man. (3) Delay in admission to hospital and treatment caused 1 death, due to hypostatic pneumonia. (4) Coexisting severe injuries caused death in 1 case.

Paraplegia.—There were in our series 19 cases of paraplegia due to spinal cord injury and of these 13 were complete and 6 incomplete. Of the 6 incomplete ones, 4 are living—one, aged 21, made a full recovery from temporary paraplegia which lasted about one hour, and returned to full service in the Navy; one, aged 37, made a good recovery and is serving in the R.A.F.; one, aged 53, made a good recovery and went back to duty as a loco-driver; and the fourth, aged 60, made a poor recovery and is a permanent cripple. In 10 of these 19 cases the cervical spine was pathological; in 12 of the 19 cases there was displacement or subluxation of the bones to be seen on X-ray films; and in 7 there was no displacement to be found—of these seven, 6 were pathological spines in people between the ages of 51 and 65.

These facts show that: (1) Temporary paraplegia can occur and result in complete recovery; (2) Incomplete paraplegia can make a good recovery—from clinical observations it was found that in these cases which made a good recovery, the progress of recovery from the nerve injury was fairly rapid and could be seen almost from day to day or week to week, otherwise there seemed to be no chance of recovery if it was not early and rapid; (3) Cases of complete paraplegia made no recovery and they died as a rule from respiratory complications from the second day to the second month; (4) Spinal cord injury appears more likely in older people, and in these cases it is likely to be associated with arthritis

of the cervical spine and can be present without any obvious displacement of the vertebral column.

Nerve-root Injuries.—Five cases seemed to have some injury to the nerve-roots, at the level of the lesion, but no evidence of paresis or loss of sensation at a lower level. Two of these died, though not from this cause. Three cases were followed for several years and appeared to suffer from a variable amount of chronic pain or ache, referred from the injured nerve to the appropriate skin areas. It was noted that in the early stages, in cases where there was root injury, hyperæsthesia might be found as well as paræsthesia. The hyperæsthesia tended to diminish fairly rapidly and disappear in the course of the first week.

Treatment.—In conducting the clinical course and treatment of these cases, standard and accepted methods were used, and the broad principles were: Early clinical and X-ray diagnosis; head traction—by halter and weights, or in the more difficult cases by skull calliper—carried out for a few days up to two weeks.

Reduction under anæsthetic was found necessary at times, and intravenous anæsthesia was preferred. Fixation in a plaster collar was used in most cases and this was fitted well down the trunk, with a forehead band to maintain the head in extension and a support under the lower jaw. Less elaborate plasters were found to give too little support in the more severe kinds of injury. The plaster was retained for three months and then replaced by an adjustable Jones collar with turnbuckle.

Paraplegia cases were nursed on sorbo or air beds, neck extension being maintained by head traction with halter. Regular nursing routine was carried out to ease pressure points. Bowel control was maintained by enemata. Bladder control was carried out by one of the following methods: (*a*) In cases of complete paraplegia with no visceral sensation, manual expression by suprapubic pressure; (*b*) In cases of incomplete paraplegia which experienced some visceral pain and in cases in which manual expression had failed, treatment was carried out by repeated catheterization, or by the more preferable method of tidal bladder drainage with indwelling catheter, our apparatus being similar to that used by Munro and Hulme.

In the later stages of the cases, root pain and post-traumatic stiffness of the neck were found to benefit by treatment by massage and radiant heat or short-wave diathermy.

SUMMARY

A review of a series of cases of fracture of the cervical spine has been made, and some facts have been given concerning the incidence of this condition in fracture clinics in hospitals in an industrial area. Analysis has been made with regard to the type of injury, the influence of age, and the frequency of fracture and displacement at the different levels of the neck. Certain features which we noted during the course of the investigation are worth emphasis.

1. The occurrence of isolated spinous process fractures is found in relation to fracture-dislocation of the neck or as isolated fractures due to muscular or direct violence on the spinous process itself. This latter type has been described adequately under the name of clay-shoveller's fractures by McKellar Hall (1940). These two types of fracture should be differentiated from one another, and if the type of violence causing the accident is that which would have been liable to give rise to fracture-dislocation of the spine, then fracture of a spinous process must be regarded as evidence that some degree of fracture-dislocation has occurred, and such cases should be regarded with suspicion and treated with the respect given to fracture-dislocations. The clay-shoveller's type of fracture is a separate entity and has not been given as wide a publicity as it justifies; it is a comparatively innocent lesion.

2. The group of fracture-dislocations comprising the series we have described were mainly to the upper part or to the lower part of the cervical spine, and of those fractures near the top of the cervical spine, fractures of the atlas, fractures of the odontoid, and displacement of the atlo-axial joint have received adequate attention in the literature on the subject. We do not think that the effect of the specialized anatomy of the axis and the result of violence upon it, have been sufficiently realized. Some reference to this was made, as we found recently, by Norman Capener, in an article on spondylolisthesis (1932). Believing that this lesion is one of some importance, we have tried to give it due prominence, as out of the 52 cases of fracture-dislocation of the cervical spine there were 6 at this level and the only real lamina fractures occurred in the axis and comprised 4 out of the 6 cases.

The probable mechanism causing this type of fracture has been discussed.

3. In cases of fracture-dislocation, complete replacement is not necessary to result in a good functional recovery, but we hold that every effort should be made to obtain and maintain as complete a reduction as possible.

4. In fracture of the lower part of the cervical column emphasis has been laid on the part which chronic arthritis may play, and the importance of it has been stressed because it appears that there is a special liability to injury of the cord with some chronic arthritic stiffening of the neck in older people who fall heavily. Emphasis has been laid also on the point that in these cases one may be unable to find radiological evidence of displacement although the patient may be suffering from complete paraplegia.

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ON SEVERE INTESTINAL HÆMORRHAGE DUE TO MYOMATOUS TUMOUR OF THE JEJUNUM

WITH A NOTE ON BLEEDING MYOMATA OF THE SMALL INTESTINE

By GORDON GORDON-TAYLOR, C.B., O.B.E.

TEMPORARY SURGEON REAR ADMIRAL

THE methods of pre-operative investigation of abdominal disease have made such strides during recent years that nowadays a diagnosis of amazing exactitude is almost invariably attained before recourse to surgery is employed to correct and cure the abdominal malady. The term exploratory laparotomy or cœliotomy has almost disappeared from the terminology of the operating theatre except in the abdominal surgery of warfare or other injury, where a complete and vigilant inspection of the entire gastro-intestinal tract and its adnexa is obviously demanded.

Nevertheless, intestinal hæmorrhage of severe degree may on occasion intransigently defy every diagnostic method which aims at localizing the source of the issue of blood and may necessitate laparotomy to identify and to cure. A careful anamnesis, the most expert radiology, the employment of gastroscope and sigmoidoscope, the co-operation of the hæmatologist, internist, and even the expert in infectious disease, may each or all fail to locate the anatomical area at fault, although by a process of exclusion the mucosal surface of the small intestine may ultimately be reckoned as incurring the gravest suspicion. Rankin and Grimes (1937), while pointing out that the source of gastro-intestinal bleeding, whether manifested by insidious occult loss, by tarry stools, or by exsanguinating hæmorrhage, may prove difficult of detection, emphasize the great value of X-ray methods in the quest; yet these authors admit that a fairly large percentage of lesions of the small bowel will not be visualized, and that abdominal exploration and a search for a tumour of the small bowel becomes necessary. Intestinal intubation with the Miller-Abbott tube, despite its value in other small-gut lesions, probably has no place in the diagnosis of a small-intestine tumour suspected as a source of serious bleeding.

CASE REPORTS

Author's Case.—

Mrs. K., 67, was operated upon in St. Saviour's Hospital by the writer for severe recurrent intestinal hæmorrhage. Great effort had previously been made by every diagnostic method and by most expert advisers in a well-known clinic, who had assigned the source of the bleeding to the small intestine. Despite the age of the patient, heterotopic gastric mucosa in a Meckel's diverticulum was considered as the probable source of the recurrent melæna. The abdomen was opened on Jan. 24, 1938, by an infra-umbilical incision. Almost immediately there was brought out of the wound a segment of small gut with a considerable projection from its mesenteric surface. The appearance of this projection from the bowel, turgid and florid with dilated blood-vessels, proclaimed in arresting fashion that here indeed was the *causa causans* (*Fig.* 230). About 8 or 9 in. of small intestine, including the

FIG. 230.—Outer surface of jejunum, showing subserous myoma at mesenteric border, which gave rise to severe recurrent intestinal hæmorrhage. Blood-vessels can be seen coursing over the tumour.

'protrusion', were resected and end-to-end anastomosis was performed; a lively satisfaction was felt that the tentative pre-operative diagnosis had apparently been confirmed.

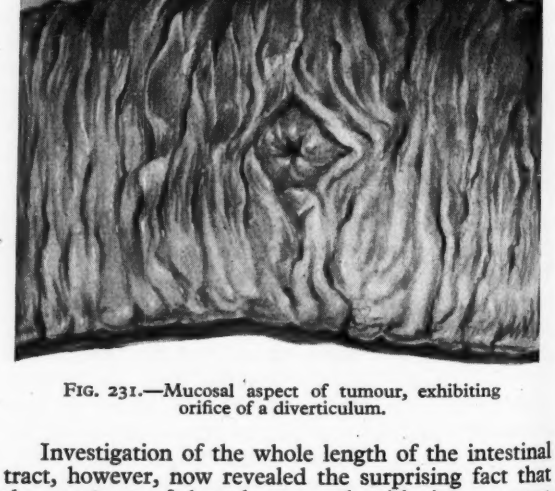

FIG. 231.—Mucosal aspect of tumour, exhibiting orifice of a diverticulum.

Investigation of the whole length of the intestinal tract, however, now revealed the surprising fact that the segment of bowel removed with its apparent diverticulum was situated not in the lower reaches of the ileum, but about 2 ft. from the duodeno-jejunal flexure (!) No other abnormality was discernible along the intestinal tract. The abdomen was closed

without drainage. The patient made a good recovery, and five years later her continued good health and the absence of further hæmorrhage from the bowel have assuredly confirmed the source of the intestinal hæmorrhage in the fibromyomatous tumour of the gut which was removed at operation.

PATHOLOGICAL REPORT (Dr. R. W. Scarff, Bland-Sutton Institute, Middlesex Hospital).—Portion of small bowel, 8 in. in length, with a tumour projecting 1¼ in. from the peritoneal surface of the mesenteric aspect of the gut. The mucosal surface of the tumour shows the mouth of a diverticulum (*Fig.* 231), probably of traction origin. Microscopical examination

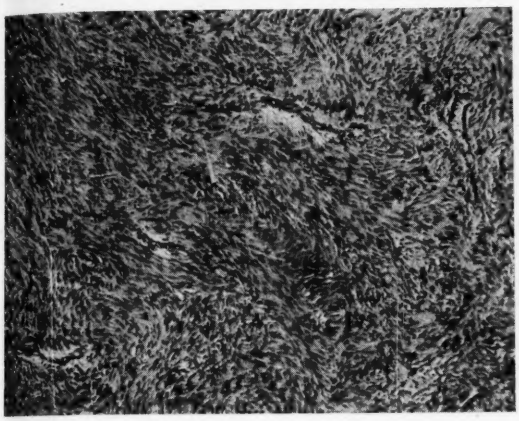

FIG. 232.—Microphotograph of the myoma of the ejunum shown in *Figs.* 230, 231.

(*Fig.* 232) shows the tumour to be composed of fibromuscular tissue; its vascularity is very obvious. There is no evidence of malignancy. *Fibromyoma.*

For the notes of the following case of fatal hæmorrhage from a leiomyoma of the small gut, I am greatly indebted to Dr. J. H. Sheldon, of Wolverhampton :—

Dr. Sheldon's Case.—

A man of 67 was admitted to hospital for a month in the very end of 1941 on account of melæna and anæmia. Conservative treatment relieved his symptoms, and the man was able to return to work for a year. At the end of November, 1942, he had another intestinal hæmorrhage of sufficient severity to render him weak and giddy on the slightest exertion, and he spent most of his day in bed. Subsequent hæmorrhage took place every month until his readmission to hospital on Jan. 31, 1943; he had steadily lost weight during these two months.

On entry to hospital he was very pale and breathless; pulse 120 and of poor volume; blood-pressure 75-40. Blood examination revealed hæmoglobin 15 per cent; red blood-cells 1,510,000; colour index 0·5. Bleeding was evidently still continuing from the bowel, and a drip blood transfusion was instituted.

On Feb. 2, 1943, operation was undertaken on the assumption that an ulcer of the duodenum was bleeding desperately. No ulcer, however, was found in stomach or duodenum, although the latter was opened. Dark blood was seen mixed with fæces through the wall of the large gut. The critical condition of the patient did not permit the inspection of the whole length of the small intestine, but the uppermost and lowermost reaches revealed no structural abnormality. The abdomen was hurriedly closed. The patient succumbed a few hours later.

At the autopsy a tumour having the dimensions of a small orange was found in the middle of the jejunum; the tumour was ulcerated on its mucosal surface; histologically, the new growth was a *leiomyoma* of the jejunum.

DISCUSSION

The briefest allusion to benign tumours of the small intestine is confined to a very few textbooks of surgery, and only one or two surgical manuals contain any reference to the possibility of severe intestinal hæmorrhage being due to their presence. It is true that amidst the wealth of lore contained in Rodney Maingot's (1936) treatise the reader will find a statement that leiomyomata of the small intestine have a tendency to bleed, that a variable amount of fibrous tissue may be found in these tumours, and that the presence of a large number of red cells constitutes a feature of the histology.

Whereas Steiner (1898) merely classified leiomyomata of the small intestine according to their anatomical relationship to the lumen of the gut, Norris Smith (1937) has added further to our knowledge of these neoplasms, pointing out that inner (submucosal) myomata and outer (subserous) myomata differ in relative frequency, clinical behaviour, and tendency to malignant transformation. Hæmorrhage which tends to recur and may be very severe is far more characteristic of the subserous group than of the submucous variety; the jejunum is the site of these bleeding subserous myomata twice as frequently as the ileum. Of 20 outer subserous myomata exhibiting intestinal hæmorrhage which were collected by Norris Smith, 8 were saved by surgery, 5 succumbed after operation, and 7 died without surgical help. This author points out by means of diagrams how progressive central liquefaction-necrosis and interstitial hæmorrhages take place in the tumour and the contents of the neoplasm are evacuated into the lumen of the gut. The firm walls of the cavity in the tumour and free drainage prevent arrest of hæmorrhage from the vascular tumour; a pseudo-diverticulum is often produced from which blood escapes into the bowel, and death may ultimately ensue unless surgical aid is forthcoming.

Wakeley and Paul (1931) also mention a dangerous degree of anæmia which may supervene in patients with myomata of the small gut.

In some of the cases of grave upper-intestine hæmorrhage decision to operate has been facilitated by the *discovery of a palpable tumour* in the abdomen. In the case of a man of 50 reported by Haggard and Floyd (1935) intermittent high-intestine hæmorrhage of undiagnosed origin had recurred for fourteen years; on one occasion bleeding had been sufficiently severe to produce syncope. Colicky pains, the loss of 30 lb. in body-weight, and the presence of a mass on the right side of the belly ultimately determined laparotomy, and a tumour of the ileum with the

dimensions of an apple was successfully resected along with the adjacent intestine. The tumour was a fibro-leiomyoma.

d'Argencourt's more recent successful case (1942) of small-intestine myoma, which produced severe hæmorrhage, was a soft fleshy tumour of considerable size, weighing 396 g. and measuring 13½ cm. × 7 cm. × 7 cm.; apart from occasioning bleeding into the lumen of the bowel, the tumour exhibited interstitial hæmorrhages.

In Max Richter's case (1909) from Hochenegg's clinic in Vienna, the tumour was the size of a man's head; the source of the intestinal bleeding was, therefore, not difficult to diagnose; this growth was probably, however, a leiomyosarcoma.

Sometimes the *supervention of some bowel complication*, such as intestinal obstruction or intussusception, may cogently demand surgery, and the secret of unexplained bowel hæmorrhage is brought to light. Moore and Schmeisser's case (1934) gave the characteristic story of recurrent tarry stools, the history extending over three years. Acute obstructive symptoms determined laparotomy; 3 or 4 ft. from the ileocæcal junction was a tumour twisted on its pedicle, and obstructing the gut. The tumour was a leiomyoma of the ileum.

It is of interest that some surgeons at laparotomy have at first regarded a subserous bleeding myomatous tumour of the intestine as a bleeding Meckel's diverticulum, an error which the writer himself committed (!). On the other hand, a bleeding leiomyoma in the wall of a Meckel's diverticulum has been encountered :—

Case.—One of the cases recorded by Joyce (1934) was a male of 19 years, who complained of weakness, fatigue, loss of weight, and the passage of black, tarry stools; these symptoms had been present for three weeks preceding admission to hospital. Blood-examination showed 2,670,000 red cells, and 37 per cent hæmoglobin. In spite of rest in bed, Sippy diet, and other therapeutic measures, the intestinal bleeding continued. No physical signs were present prior to operation which appeared to inculpate the small intestine. On laparotomy a Meckel's diverticulum was present, full of blood, and a small ulcerated mass, 1·5 cm. in diameter, was found in its wall. Microscopically, the tumour proved to be a rapidly growing leiomyoma.

The bleeding may be *sufficiently severe to occasion a fatal result*. Mercer (1888) reported a fatal case of profuse bleeding from a myoma of the ileum; no operation was performed. Rosenow (1912) also reported a fatal case which had been erroneously regarded as due to a bleeding duodenal ulcer. Ranzi's (1913) case of bleeding from a myoma of the jejunum died of pulmonary embolism twelve days after operation. Goldschmidt's case (1923) of small-gut myoma died in the Eiselberg clinic in Vienna.

Despite large transfusions of blood, Norris Smith's (1937) patient died unoperated upon on the seventh day; the second case recorded in this present communication terminated fatally. Hake's (1912) patient, a woman of 49, was admitted to hospital in a moribund state from anæmia; the tumour was a pure leiomyoma of the size of a walnut, which had bled into its own tissues as well as into the lumen of the bowel.

Frequent admission to hospital or clinic for unexplained high-intestine bleeding is very characteristic of the history of the patients with a bleeding leiomyoma of the jejuno-ileum. Cabot's (1930) patient, a woman of 51, was admitted to hospital three times in the course of thirteen months before laparotomy revealed a myoma of the small gut to be the cause of the bleeding, and in the intervals between her sojourns in hospital she had several times been under the observation of her private medical attendant because of the passage of tarry stools. The hæmorrhage had been sufficiently severe to produce beating in the ears, a sensation of mild oppression in the chest, and shortness of breath, and palpitation on climbing stairs or walking only a short distance. The hæmoglobin had registered only 50 per cent on several occasions, and the red blood-count was only 3,200,000. The diagnosis had varied between the bleeding of a silent duodenal ulcer, secondary anæmia (!), cirrhosis of the liver, and "bleeding from the gastro-intestinal canal" (!) Tardy exploration of the abdomen disclosed a pedunculated nodular tumour, 4 cm. × 5 cm. × 5 cm., with a shallow ulcer on its mucosal surface; this growth, like so many leiomyomata of the small gut, was situated in the jejunum, about 3½ in. from the duodeno-jejunal flexure. The growth was said to be a leiomyosarcoma, a good prognosis being given.

A case reported by Joyce (1934) concerned a woman of 49 who was first seen in 1929, when she passed a large quantity of dark clotted blood by the rectum and then fainted. The hæmoglobin fell to 20 per cent, and the red blood-cells to 1,330,000. There was no history of any pain or gastro-intestinal discomfort. The patient was treated conservatively and transfused.

During the next year or two the patient developed symptoms for which a hysterectomy was performed, and some internal hæmorrhoids were cauterized. Five years after the first upper-intestine bleeding, she again passed dark, tarry stools, and her hæmoglobin fell to 27 per cent. Radiology revealed several opaque shadows in the area of small intestine on the left side of the belly. A tentative diagnosis of a diverticulum or an intestinal polyp was made. Operation revealed a mass about the size of an egg about 8 in. below the duodeno-jejunal flexure; a resection of the portion of the implicated jejunum was successfully performed. The tumour was a large intramural and polypoid leiomyoma with ulceration of the mucosa.

The importance of an ulcer-history has sometimes not been sufficiently evaluated in the endeavour to diagnose the source of the hæmorrhage in some cases of high-intestine bleeding; the silent duodenal ulcer has been sometimes

erroneously impugned as the cause of bleeding, and an *unnecessary gastrojejunostomy* has even been performed (G. G. Finney, 1933).

Tumours originating in the muscle of the wall of the small intestine are relatively infrequent; most are frankly benign, but some have malignant tendencies; the degree of malignancy is not readily gauged by histological criteria. According to Dorling (1929) and McFarlane (1935), the only proof of malignancy is the presence of metastases; it is significant that only 9 out of 109 cases reviewed by Norris Smith did metastasize, and most malignant leiomyomata (leiomyosarcomata) metastasize slowly (Klopp and Crawford, 1935); thus Stewart, of Philadelphia, operated upon a patient who did not develop a recurrence for fourteen years. In another patient, Demel removed a tumour from the liver, and the autopsy performed two years subsequently revealed a malignant leiomyoma of the jejunum. The low degree of malignancy of leiomyosarcomata of the small bowel is in marked contrast to myosarcomata of the uterus.

X rays are not as helpful in the diagnosis of tumours of the jejuno-ileum as they are in cases of tumour elsewhere in the gastro-intestinal tract; the considerable length of the small intestine and the difficulty of filling the lumen homogeneously explain the meagre aid afforded in diagnosis. While negative information from X-ray examination does not exclude tumour of the small gut, positive results are of very definite value. The latter are more prone to be encountered in constricting tumours, polypoid masses, etc., and are less likely to be met with in the bleeding leiomyomata, which are frequently subserous in site and may alter the mucosa but slightly.

The subserous myomata of the small intestine associated with intestinal hæmorrhage appear to have a predilection for the jejunum, especially its upper coils (Rosenow, 1912; and others). Diagnosis is therefore likely to be fraught with uncertainty. The cases are recorded and the subject is discussed here in order to remind surgeons of a source of intestinal hæmorrhage which may be forgotten, which in many cases cannot be located before operation, which is curable by surgery, and for which exploratory laparotomy must be carefully considered before it is too late to save life.

SUMMARY

Leiomyoma of the small intestine may occasion severe, even fatal, bowel hæmorrhage, and should be remembered as a possible causal condition in unexplained intestinal bleeding. The bleeding Meckel's diverticulum is chiefly encountered in childhood and early adolescence; the leiomyomata of the small bowel occasion hæmorrhage at a later period of life.

I labour under a debt of gratitude to my friend and colleague, Dr. R.W. Scarff, who furnished the pathological report.

The illustrations are by my old friend, the late W. Thornton Shiells. The microphotograph has been prepared by Mr. Frank Baldwin, of the Bland-Sutton Institute, Middlesex Hospital, to whom my best thanks are due.

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MULTIPLE CAVERNOUS HÆMANGIOMAS OF THE LUNGS SUCCESSFULLY TREATED BY LOCAL RESECTION OF THE TUMOURS*

By ROBERT M. JANES, Toronto, Canada

Hæmangioma of the lung would appear to be rare. I have been unable to discover a report of the treatment of the condition by local resection of the individual tumours. The case reported by Rodes (1928) would seem to have been similar to the one upon which this report is based except that a secondary polycythæmia had developed. Rodes's patient died of hæmorrhage. It is possible that his life could have been saved by removal of the tumours.

Hepburn and Dauphinee (1942) have reviewed the literature upon this subject so recently that it will not be duplicated here. Hirsch (1936) called attention to certain pulmonary lesions that he had observed in cases of polycythæmia vera which might be confused with multiple hæmangiomas in which a secondary polycythæmia had developed. The X-ray film shadows described by him were apparently more definite and circumscribed in character than those produced by hæmangiomas and, in addition, were transient. Should there be doubt about the X-ray findings, repetition of the films after the lapse of a few weeks should clarify the diagnosis. Shadows such as reported by Hirsch have not been observed in our medical wards (Farquharson).

CASE REPORT

History.—Mr. R. B., aged 30 years, a printer by occupation, was first seen on Sept. 25, 1941. Following some unusually strenuous exertions at a military camp a little more that one year previously, he had coughed up bright red blood. A few days later, while running across the camp, much more serious bleeding occurred. Radiographs of the chest made at that time were reported as negative. Repeated examinations of the sputum showed no tubercle bacilli. He was discharged from the army and remained well for a year. One month before consulting me he again coughed up blood on three occasions in one week, the last hæmoptysis amounting to at least a cupful. In the ensuing year he had lost 6 lb. in weight. The past history was uninteresting except that two years previously, following the introduction of a gum-arabic spray into the printing plant in which he worked, he developed asthma. He had been transfered to an outside job and there had been no recurrence of the asthmatic symptoms. It seemed reasonably clear that this condition bore no relation to the hæmoptysis.

Examination.—He was a rather thin and pale young man weighing 122 lb. The lips and finger-nails were definitely cyanotic. There were multiple small hæmangiomas on the lower lip (*Fig.* 233); the exact duration of these was unknown, except that they had been there for "a long time". Physical examination, including an examination of the chest, disclosed no further abnormality. A soft blowing murmur was discovered by the house surgeon a few days later in the region of the right cardiophrenic angle.

During a short period of observation in hospital there was no fever, no cough, and no sputum. At a bronchoscopic examination no blood was seen and there was no suggestion as to the source of the former bleeding. The white blood-count was 11,400 (neutrophils 78 per cent, lymphocytes 20 per cent, and eosinophils 2 per cent). The shape of the red cells was normal. There was marked microcytosis and hypochromia. The sedimentation rate was 8 (Westegren). The tuberculin test was negative. Radiographs of the chest showed two shadows in the right lung and one, or possibly two, in the left (*Figs.* 234, 235).

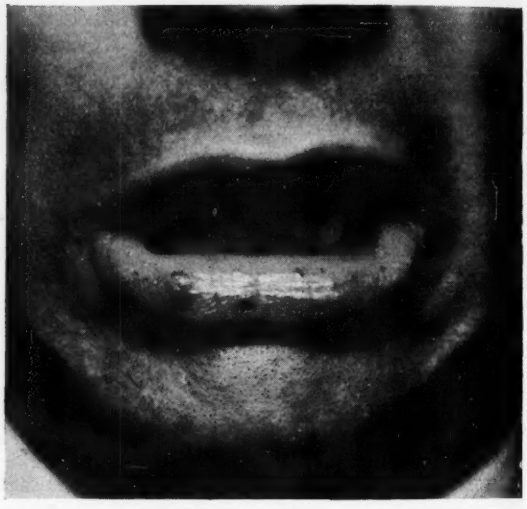


Fig. 233.—Photograph of lower lip, showing the multiple small hæmangiomas.

It was felt that the diagnosis lay between multiple hæmangiomas of the lung and multiple adenomas. Had one paid more attention to the house surgeon's finding of a soft murmur and been aware of Rodes's report, a definite diagnosis of hæmangioma could have been made. An exploration of the chest seemed warranted and since there was no hint as to which side the blood had come from, it was decided to operate first upon the right side, since these shadows were larger.

First Operation (Oct. 4, 1941).—Under intratracheal cyclopropane anæsthesia, the right chest was opened through a long postero-lateral incision. There were no pleural adhesions. Two hæmangiomas were at once seen, one about the size of a hen's egg on the posterior margin of the lower lobe and one about half as large on the margin of the middle lobe. They were pulsating freely and a marked thrill could be felt on gentle pressure with the finger. They could be almost completely compressed. The blood-supply, particularly of the larger, was evidently enormous. The remainder of the right lung was normal.

* From the Department of Surgery of the University of Toronto and the Toronto General Hospital.

Since it seemed probable that the lesions in the left lung were of a similar character and should be operated upon at a later date, it was decided to attempt a local resection. The pleura over the base of the larger lesion was incised and four vessels each about 5 to 6 mm. in diameter isolated, ligated with fine silk,

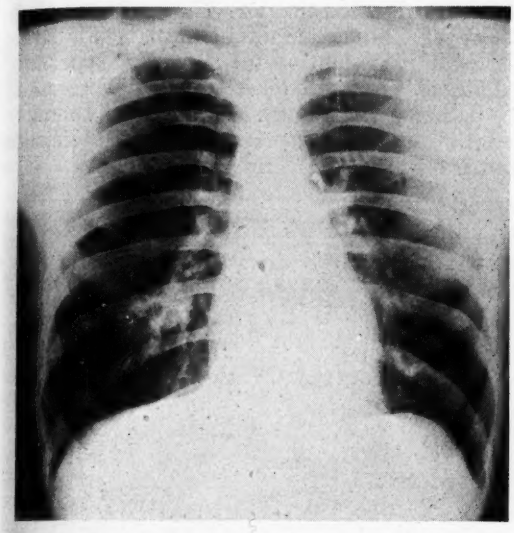


FIG. 234.—Postero-anterior view. The shadows are rather indistinct and fade somewhat into the surrounding lung tissue.

and divided. The blood-supply to the tumour was now controlled, and it was easy to dissect the growth from the surrounding lung tissue. The excavation in the lung was obliterated and oversewn with chromicized catgut. The blood-supply of the smaller tumour was controlled by simply passing a wedged intestinal needle deep to it and doing a mass ligation, following which the tumour was removed and the defect in the lung dealt with as before. The chest was closed without drainage, the air being exhausted through a catheter before the final stitches were pulled taut. Recovery was uneventful.

On Jan. 15, 1942, he was feeling well, working, and capable of much more exertion than formerly. The cyanosis was distinctly less. He continued in good health.

SECOND OPERATION (June 25, 1942).—Under intratracheal cyclopropane anæsthesia, the left chest was opened through a long postero-lateral incision. There were no pleural adhesions. On the costal surface near the posterior rounded border of the lower lobe was a hæmangioma 1 in. in diameter and on the lower border of the lobe more anteriorly a second tumour 1 cm. in diameter. The remainder of the lung appeared normal. A photograph of the larger tumour was obtained (*Fig.* 236). Each tumour was resected over forceps and the defect in the lung closed with a running suture of catgut. The chest was closed as at the former operation and the post-operative course was again without incident.

There seems to have been a further improvement in health and an increase in exercise tolerance.

PATHOLOGY.—

Oct. 4, 1941, S.41/5081. One specimen measured 5 × 4 × 3 cm., the other 3 × 4 × 2 cm. The outer surfaces were covered by pleura. Sections taken through the lung tissue in the vicinity of the dilated and prominent vascular channels confirmed the clinical diagnosis. These channels appeared to be greatly thickened and sclerosed venous structures rather than arteries. Their walls showed irregular thickening, most of which was due to intimal hyperplasia. The adjacent lung parenchyma was partially

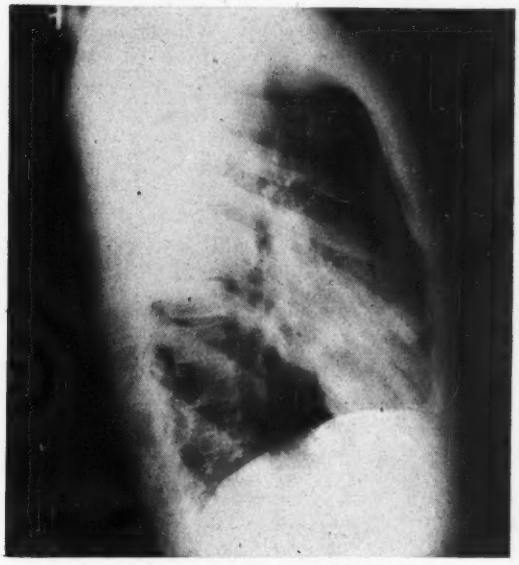


FIG. 235.—Latera lview. Two of the tumours are shown.

collapsed and chronic passive congestion was evidenced by large numbers of alveolar macrophages filled with hæmosiderin.

June 25, 1942, S.42/3311. One specimen measured 7 × 2 × 1 cm., the other 1·5 × 0·8 × 0·4 cm.

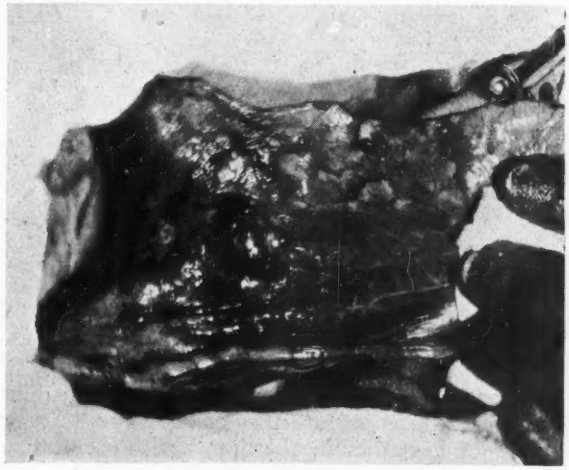
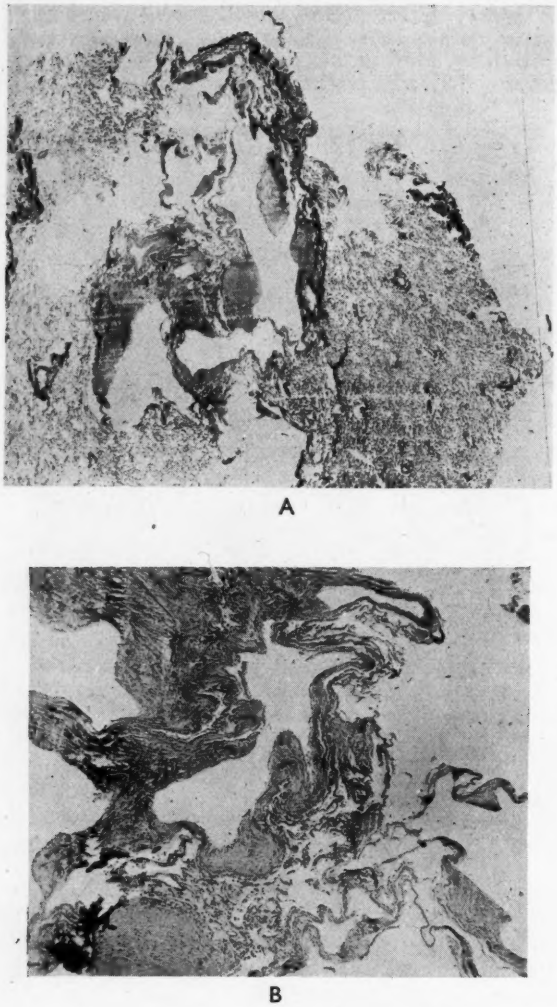


FIG. 236.—Photograph of larger tumour on the left side, taken at the second operation.

Sections showed a number of well-defined blood-vessels with marked dilatations forming cavernous spaces just beneath the pleura. Many of these spaces were filled with blood. (*Fig.* 237.)

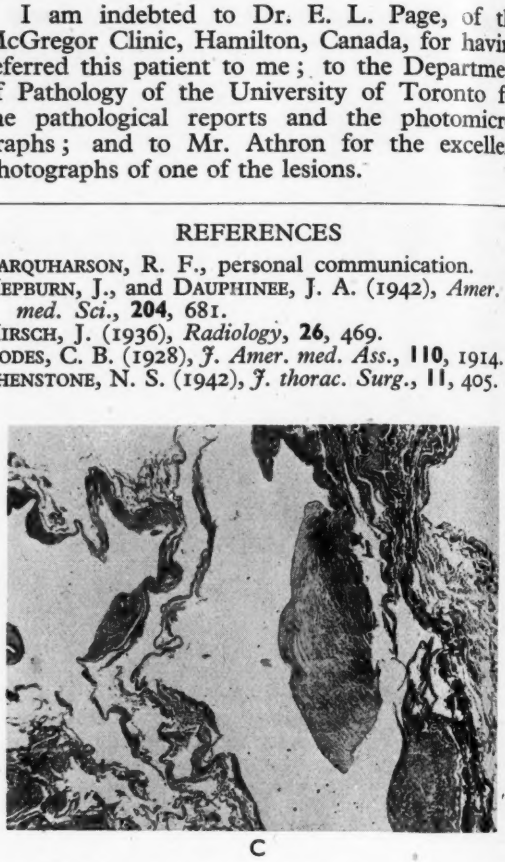
SUMMARY

The diagnosis of multiple hæmangiomas of the lung is dependent upon familiarity with the clinical picture that they produce. The condition



A

B



C

FIG. 237.—Photomicrographs of tumours removed from left lung. A, × 10; B, C, × 14. (Stained H. and E.) (*See text.*)

can be treated successfully by local resection of the individual tumours providing none of the lesions are too massive, in which case a lobectomy or pneumonectomy would be preferable. Because of the danger of fatal hæmorrhage, operation should not be delayed.

I am indebted to Dr. E. L. Page, of the McGregor Clinic, Hamilton, Canada, for having referred this patient to me; to the Department of Pathology of the University of Toronto for the pathological reports and the photomicrographs; and to Mr. Athron for the excellent photographs of one of the lesions.

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CONGENITAL DISLOCATION OF THE SHOULDER

BY GEOFFREY FLAVELL
SQUADRON-LEADER, SURGICAL SPECIALIST, R.A.F.V.R.

DISLOCATION of the shoulder as a congenital malformation is so rare that at one time its very existence was called in question, and the deformity attributed to birth injuries or nerve palsies by a number of writers. The weight of evidence, however, is overwhelmingly against any such hypothesis, in spite of the very small number of cases on record. In fact, one may say that there is little or nothing to support the theory of natal or neonatal injury, and in 1898 Kirmisson and Broca failed completely to produce shoulder dislocation experimentally in the newly-born dead fœtus, and categorically denied trauma as a possible factor. Grieg in 1923 confirmed their view, and expressed the opinion that it would be necessary to cause a glenoid fracture to bring about a birth dislocation.

Apart from other considerations, the presence of a small number of bilateral dislocations, such as the present instance, and the finding of numerous other indisputably congenital abnormalities in association with the shoulder deformity, is convincing evidence of its congenital character. Of the bilateral condition Cruveilhier wrote in 1849, " Il suit de là que la constatation des luxations sur les enfants nouveaunés serait la preuve la plus directe de la nature congenitale d'une luxation ".

That secondary types of unilateral shoulder dislocation may occur during birth, or after, as a result of obstetric manipulation or paralysis is, however, a possibility, so that the history of a difficult birth, the presence of paralysed muscle groups, or the absence of other developmental anomalies must render a claim to congenital origin open to doubt; and Lewis Cozen says, "There is no doubt . . . that paralysis caused by an injury to the brachial plexus will cause, or accompany, dislocation of the shoulder". For this reason certain examples in the literature of unilateral dislocation associated with one or other of the above factors have been put on one side as being dubiously congenital. Grieg has suggested the following classification: (1) True congenital dislocation; (2) Dislocation due to obstetric manipulation; (3) Dislocation following paralysis.

HISTORICAL.—In 1839 R. W. Smith first recorded in the *Dublin Journal of Medical and Chemical Science* the story of two women of 29 and 42 respectively. The first was mentally defective and paralysed, and had bilateral subcoracoid dislocations; the other was also a defective who had vaguely described pareses, but with bilateral subacromial luxation. A post-mortem on both women showed an extension of the glenoid to the site of the luxation, and both had flattened humeral heads and much osteophytic formation. In spite of the associated paralyses, the bilateral character of these dislocations makes it likely that they are the first recorded of their kind.

Guérin in 1841 described a bilateral example in a symmelian fœtus, and two others which were unilateral. This was followed by Kuster in 1878, who recorded bilateral congenital subspinous dislocation in an infant of one year. He rashly excised the humeral heads, sepsis intervened, and the child died.

Scudder in 1890 found two children, 7 and 9 years old, in one family, each of whom had a a right subspinous congenital dislocation. Births had been normal and easy, there were no palsies, and of them Grieg says, "this case alone would prove congenital occurrence".

Peckham in 1898, Cumston in 1903, Roberts in 1905 and 1909, and Hitzrot in 1912 all added further examples, the latter's being an 8-year-old girl whose birth was normal, who had no pareses, but who had a subspinous dislocation of the left shoulder, the humerus resting upon a facet on the posterior surface of the glenoid. In 1907 Openshaw reported a bilateral subglenoid congenital dislocation.

Grieg, who reviewed the literature in 1923, found only 10 cases in which the evidence justified the conclusion of true primary congenital dislocation, and of these only 2 were bilateral. In all, since 1923, 11 additional instances (apart from the present one) have been recorded, and of those 1 is of doubtful authenticity.

Frosch in 1925 added 3 cases, in each of which the lesion was bilateral, and in all radiographs demonstrated abnormally flattened glenoids. Edwards in 1928 performed an autopsy upon a man of 46 both of whose shoulders had been dislocated since birth, and showed that the glenoids were completely absent. This again is a conclusive proof of a truly congenital origin.

The following year Wolff described a patient in whose family a similar condition had been observed for three generations, and associated anomalies such as absent thumbs, rigidity of the elbows, synostoses of the radio-ulnar joints, and amyoplasia congenita were also present. Valentin in 1931 found three affected members of one family, radiographs showing posterior dislocations with flattened glenoids.

Lewis Cozen contributed one case identical with Wolff's in 1937, this time in a boy of 4, who provided a florid display of anomalies, having atrophy of the muscles of his shoulder girdle, contractures at both elbows, synostoses of the radio-ulnar joint, an absent right thumb with a rudimentary left, limitation of movement at all the phalangeal joints, amyoplasia congenita, and, to crown all, a patent ductus arteriosus. Radiographs showed maldeveloped glenoids and pyramidal heads. Pfeiffer and Salaghi, in 1938, each brought forward a child with unilateral dislocation. Until now no others have been reported.

To summarize, therefore, since 1839 20 unquestionable examples of true congenital dislocation of the shoulders have been described, and of these some 7 were bilateral.

CASE REPORT

The patient, a healthy, well-built, and intelligent boy of 11, was brought to see me because his father had noticed that he cou'd not bowl at cricket. Previous to this time no disability had been observed. Unfortunately, for various reasons, no obstetric history was available. There was no record of any trauma.

ON EXAMINATION.—Wasting of all the muscles of the shoulder girdle was apparent, but there was no paralysis, and the electrical reactions were normal. The humeral heads were bilaterally dislocated, lying in the subcoracoid position, but they could be readily reduced, and held in place by a muscular effort, or pushed into a subspinous situation.

X-ray films showed a complete absence of the glenoid cavities, but there was no flattening of the heads (*Figs.* 238, 239). Both shoulders were hypermobile, and the boy could demonstrate this in dramatic fashion by clasping his hands behind his back and bringing them up, over his head, and to the front without unclasping them. This feat had often been performed to win wagers from his school friends. The movements were quite painless.

None of the anomalies seen in the cases of Cozen and Wolff were present, but there was a remarkable degree of hyperextension at both elbows, the angle of forearm upon upper arm being 156° on the right side, and 148° on the left.

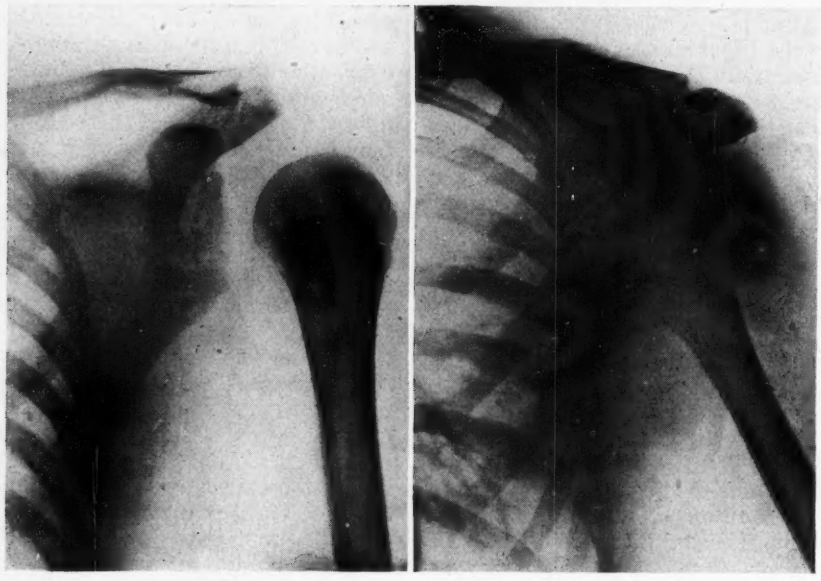
The ductus arteriosus was not patent.

TREATMENT.—In the present instance, as the joints had full range of movement and were painless, operative treatment was deprecated (at least until growth was complete), and the patient given graduated exercises and electrical stimulation to the shoulder

girdle muscles with the object of repairing the wasting and increasing the stability of the joints. After three months there was improvement in this respect.

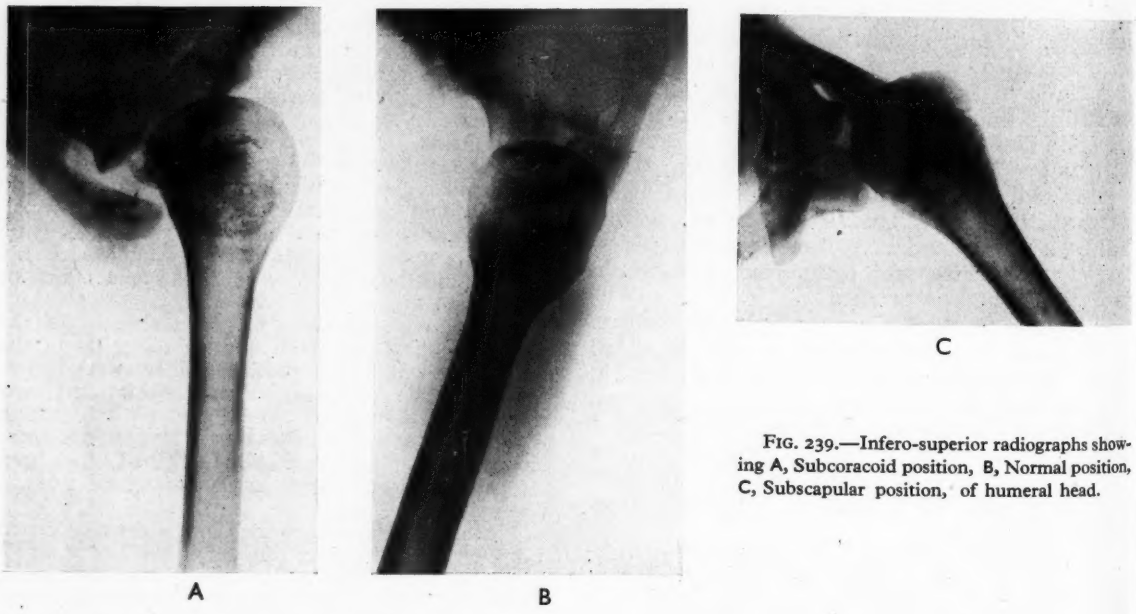
COMMENT

In the past a great variety of procedures have been tried with varying success. Cumston (1903) reported good results with simple open reduction. Peckham (1898), Roberts (1905, 1909), and Hitzrot (1912) resected the head of the humerus. Whitman (1905) recommended manipulation with subsequent immobilization in a plaster spica. Cozen (1937) performed a Nicola operation on the right shoulder of his patient, a reefing of the capsule performed three years before having resulted in recurrence of the dislocation. The left capsule he reefed when the child was aged 4, with satisfactory results.



A B

FIG. 238.—Antero-posterior radiographs showing humeral head in A, Neutral position; B, Subcoracoid position.



A B C

FIG. 239.—Infero-superior radiographs showing A, Subcoracoid position, B, Normal position, C, Subscapular position, of humeral head.

The problem posed is obviously a difficult one which can be decided only on individual merits, but the probability of secondary arthritic changes in later life must be remembered, and is, perhaps, inevitable.

SUMMARY

1. Congenital dislocation of the shoulder is a well-documented condition, and twenty examples are to be found in the literature since 1839. Of these seven were bilateral.

2. A new bilateral instance is described, and the treatment reviewed.

I am grateful to Mr. R. Watson-Jones for his advice in connexion with this patient.

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MESENTERIC DEFECTS

BY E. G. DOLTON

RESIDENT ASSISTANT SURGEON, ST. THOMAS'S HOSPITAL

Site.—In 1885, Treves drew attention to the rare occurrence of holes in the mesentery of the terminal ileum. To the cases he examined he gave the following general description: "The holes were round; they were situated in the mesentery of the terminal part of the ileum; their margins were distinct, being often thickened and opaque, and around a part of the margin it was not uncommon to find one of the terminal branches of the superior mesenteric artery.... In the fœtus at full term and in children up to puberty they are normally about the size of a shilling piece." Treves's article is illustrated by the accompanying diagram (*Fig.* 240), and he points out that the area in question is remarkable for its lack of fat, blood-vessels, and lymphatic glands, even where no actual breech exists—in the body of a man of 52 years he found such an area so thin that it had become cribriform. In view of these findings, he considered that the circular lacunæ were congenital, and that slit-like areas were likely to be traumatic.

FIG. 240.—'Treves's field'—the anastomotic ring formed by the ileocolic and the last ileal artery.

This area, the so-called 'Treves's field', is by far the commonest site for lacunar formation, as shown in the 76 cases found in the literature by the reviewer. Cullen (1936) found a defect in the mesentery of the ascending colon, as did Hansmann and Morton (1939), whilst Turel (1932) discovered an aperture in the mesosigmoid. The other cases of abnormal site are merely variants of the classical description: Gatewood (1934), Hamaker (1914), and McWorter (1928) described 1 case each where the defect was near the root of the mesentery; whilst in each of the solitary cases recorded by Judd (1929) and Markheim (1941), the lacuna was situated near the centre of the mesentery. Out of 31 cases collected by Prutz (1907), 17 lay in the mesentery of the terminal ileum. Probably the most interesting from the topographical and aetiological standpoints, is the four-day old child cited by Long (1927), in which there were multiple openings along the terminal 20 cm. of the ileal mesentery, through one of which bowel had passed and become obstructed. The margin of the defect is always smooth, regular, and usually thickened and opaque; in almost all cases reviewed the hole

has been circular, an oval or slit-shape being the exception. The recorded diameter has varied from 1 cm. to 12 cm., the average being 2 cm.

Aetiology.—Prutz comprehensively classified the aetiological possibilities as follows: (1) Congenital; (2) Spontaneous (through atrophy or rarefaction); (3) Traumatic; (4) Operative; (5) Following chronic inflammatory processes.

Treves considered that most mesenteric holes were congenital, stating that the usual circular type was of this nature, whilst the rarer slit-like type was probably traumatic in origin. Watson (1935) found a hole in the mesentery in 3 out of 1600 post-mortem examinations, and each lay near the ileocæcal junction, whilst in none was a hernia present. The occasional finding of that bloodless, fatless, rarefied area of peritoneum enclosed in a loop of the terminal ileal mesenteric vessels, described by Treves, in routine autopsies for unassociated pathology is strongly in favour of a congenital origin, as is Treves's own case (*see above*) where the area in question was cribriform. Ménégaux (1934) considered that the fenestration occurred during the developmental enlargement of an inadequately vascularized area, and this view seems well confirmed by Long's case of multiple fenestration between the lower ileal vessels.

Federschmidt (1920) showed that while there is a regression of the ventral mesentery in man, in other mammals the dorsal mesentery is also involved; he suggested that congenital defects in the mesentery represent a partial regression of the dorsal mesentery in the human being; here again Long's case seems pertinent. Judd (1929), quoting Mall, suggests that the migration of the intestine into the umbilical cord at the seventh week of fœtal life is due to the pressure of the rapidly growing liver, and that this pressure may force bowel through the mesentery.

Hohlbaum (1920) thought the condition inflammatory, whilst King (1935), arguing from his own case, concluded that some mesenteric herniæ may be due to appendicæcal inflammatory adhesion to mesentery producing spread of inflammation into the latter, leading to obliteration of blood-vessels and fibrosis. This fibrosis draws up the small gut which becomes adherent to the appendix through the avascular area, which then disappears. However, no other authors seem to champion the inflammatory theory, and there seems little to support its validity. There seems no anatomical reason why the postulated inflammatory cause should almost always pick the same area in which to produce atrophy—all other mesenteries would be liable to similar formation of lacuna, such as from diverticulitis, and anyway, only King's case shows any evidence of inflammatory origin. The recorded cases do not suggest any past history of likely inflammation, most coming on as acute intestinal obstruction, and an inflammatory cause, either recent or long past, has not been found at operation or post-mortem examination.

The chief rival of the congenital theory is that trauma is the responsible factor. In Brown's case (1920), a boy of five years fell down two steps and struck his dorsilumbar region—the child continued his play, but the same evening complained of abdominal pain and vomiting; the pre-operative clinical picture was that of intestinal obstruction with peritonitis, and operation (third day after onset of symptoms) revealed that 20–30 cm. of lower ileum had passed through a 3-cm. opening in the mesentery, had twisted upon itself, and had become gangrenous. The opening was 5 cm. above the cæcum, and had rough edges apparently of recent origin. The presence of free blood in the peritoneum at operation is not recorded as evidence of mesenteric tear, but the tear, if such it were, may not have implicated a blood-vessel of any size.

Long's case of a four-day old child, which showed multiple fenestræ along the terminal 20 cm. of mesentery, through one of which the last 35 cm. of ileum had passed and become twisted and obstructed, was associated with a pressure deformity of the thorax, so might be considered traumatic in origin. No other case, however, has any recorded history of possible aetiological trauma. It has been considered that a blow on the abdomen might cause the ileal mesentery to be torn across the projection of the vertebral column, without producing any symptoms of note, but such a disruptive force would almost certainly produce some degree of hæmoperitoneum, and in addition would be surely more likely to cause bowel rupture. At all events, sufficiently severe symptoms would be produced to be remembered by the patient or even need medical attention.

The constancy of site of these holes, and their almost invariable similarity to Treves's original description, combined with lack of surrounding adhesions (which might be expected to result from trauma or inflammation), all lead to the conclusion that such mesenteric lacunæ are congenital in origin. Further, it may be pointed out that the ileocæcal mesentery, due to the descent of the cæcum, undergoes considerable and rapid lengthening during fœtal life.

Clinical Manifestations.—The condition always presents as acute intestinal obstruction without any specific symptoms or signs: rarely is there previous suggestive history. Cullen's case had had four or five previous attacks of abdominal pain relieved by vomiting, as had Gatewood's second case. King records a past history of three months' pain in the right iliac fossa, whilst A. M. Smith's case (1932) had had two weeks' intermittent abdominal pain. But these four cases are the only exceptions.

However, there is adequate indication for laparotomy, and reduction of the hernia, the bowel being dealt with according to its viability, automatically follows. In almost all cases the holes can be closed, probably best with continuous silk. The mortality is high, and varies from

28·5 per cent, according to Edwards (1932), to 50 per cent deduced independently by both Prutz and A. M. Smith. Of the cases reviewed in this article, where the end-result has been definitely stated, there have been 16 recoveries and 8 deaths—a mortality of 33 per cent.

CASE REPORT

HISTORY.—Mrs. C., aged 33 years, was admitted to St. Thomas's Hospital on June 28, 1942, complaining of thirteen hours' severe, constant, non-colicky pain in the right iliac fossa, radiating to the left iliac fossa. Anorexia was present, and the patient had vomited twice since the onset of pain. No headache; bowels regular; micturition normal. Married ten years, now pregnant four months for the first time.

Past History.—Acute rheumatism with pericardial effusion, 1938. Tuberculous cervical adenitis, 1940. In St. Thomas's Hospital in 1941 for investigation of intermittent, mild, generalized abdominal pain, with diarrhœa and lassitude, of two months' duration. The alimentary and renal tracts, and cardiovascular system, were fully investigated, and no cause found. This was the only abdominal upset of note previous to the present illness.

ON EXAMINATION.—Temperature 98°, pulse 68, respirations 20. Dry, furred tongue. Examination of the abdomen showed generally diminished respiratory movement, with rigidity and slight tenderness in the right iliac fossa, the latter being maximal over McBurney's point. There was rectal tenderness on the right.

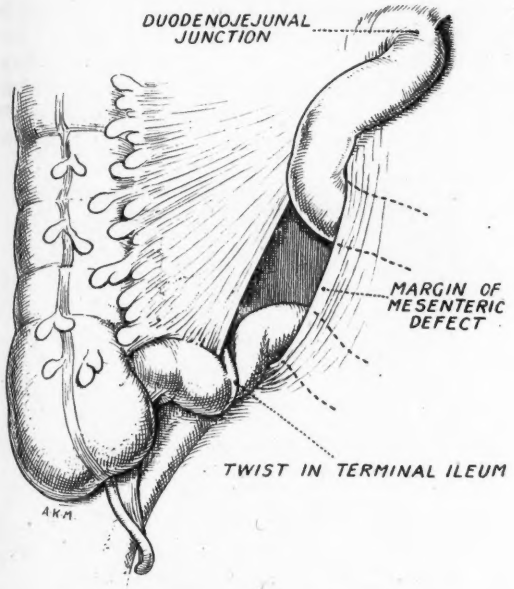

FIG. 241.—Operative findings in author's case.

OPERATION (E. G. D.).—Under pentothal, nitrous oxide, and local anæsthesia. Fifteen hours after onset of pain. Right paramedian incision. The appendix was normal, but an oval defect, with its long axis in the vertical plane, was found in the mesentery of the terminal ileum. Through this, all the small bowel, from just below the duodeno-jejunal junction downwards had passed from in front until the terminal ileum was tightly twisted on itself and so obstructed. (*Fig*. 241.)

The herniation was reduced and the bowel found to be viable. The defect could then be seen to be 4 in. by 2 in., with regular, smooth, and slightly thickened edges, with the terminal ileal artery closely adjoining the left margin. The hole was closed with interrupted silk sutures, the appendix removed, and the abdomen closed.

The patient made an uneventful recovery and has since had a live full-term child.

SUMMARY

1. The subject of mesenteric defects is reviewed, together with the literature, and its aetiology discussed. Reasons have been given why the condition should be considered congenital in origin.

2. A further case of intestinal obstruction due to this cause is added to those already recorded.

I wish to thank Mr. R. H. O. B. Robinson, under whose care this patient was admitted to hospital, for permission to quote the case history. It is at his suggestion that this article has been written. I am also grateful to Mr. A. K. Maxwell for the drawings.

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FRACTURES OF THE TRIQUETRUM

By J. GRANT BONNIN and W. P. GREENING

THE concentration of attention on the navicular has caused the other bones of the wrist to be neglected. We would like to rectify this in the case of the triquetrum, and emphasize the fact that fracture of this bone is commonly misdiagnosed as fracture of the posterior pole of the lunate. Böhler, quoting Schnek's statistics, first brought this latter diagnosis into prominence. In our opinion he exaggerated its frequency, isolated fracture of the posterior pole of the lunate being very rare, and only seen by us twice in a series of over a thousand wrist injuries.

ANATOMY

The triquetrum is exceptional in having no part in the radiocarpal joint, but in taking part in the midcarpal joint, and moving freely with the lunate. This degree of mobility of the

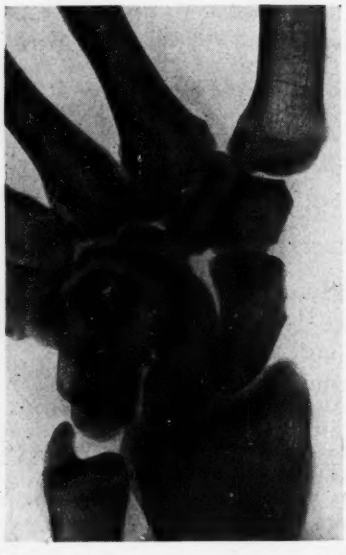

FIG. 242.—Wrist in ulnar deviation, showing the possibilities of compression of the triquetrum.

triquetrum is accomplished by leaving a space between the proximal pole of the triquetrum and the triangular fibrocartilage passing from the base of the styloid process of the ulna to the radius, and this space is filled with loose areolar tissue. Though there is thus no joint or bursa on the distal side of the fibrocartilage, the effect is the same. The triquetrum, roughly pyramidal in shape, inserts its sharpest angle between the lunate and the hamate; this wedge insertion would produce a tendency to extrusion of the bone in falls on the extended hand, if this weakness were not counteracted by the fact that in falls on the extended hand the wrist moves into ulnar deviation, and the triquetrum swings more deeply into the wrist under cover of the lower end of the ulna (*Fig.* 242).

Inspection of the volar surface of the bone shows the facet for the pisiform to lie at the apex of this surface, and thus a quadrangular surface is left between it and the edge of the articular surface for the lunate for the attachment of the volar intercarpal ligaments. Of the three remaining surfaces two are completely articular, for the lunate and hamate, and the third, which looks dorsomedially, corresponds to the double curved surface of the proximal row of carpal bones. It is marked by a groove, visible in most anteroposterior views of the wrist though not infrequently overlain by the shadow of the pisiform. Of the two areas thus delineated the smaller lateral area is for the attachment of the ulnar collateral ligament of the wrist, and forms a marked colliculus corresponding to the tuberosity of the navicular on the other side of the wrist. The larger and more medial area is again subdivided by a fainter line, the proximal facet being smooth and in contact with the areolar tissue previously mentioned. Owing to the curve of this surface of the bone, the distal facet comes to lie more on the dorsum of the wrist, and forms the posterior tubercle serving for the attachment of the dorsal intercarpal ligaments, which radiate from it in four directions, two ligaments branching

FIG. 243.—Fracture of the radial corner of the triquetrum, from impact against the radius.

proximally to the styloid process of the ulna and the lower end of the radius, and two distally to the hamate and capitate. It is this prominence which is most frequently injured by indirect violence.

If the wrist is fully palmar flexed, three prominences forming an equilateral triangle can

be palpated on its dorsomedial aspect; the large rounded lower end of the ulna, the ulnar side of the lower end of the radius, and, least distinct, between the extensor digiti quinti and the extensor carpi ulnaris, the posterior tubercle of the triquetrum.

MODE OF INJURY

Direct injury to the triquetrum is rare owing to its protection by the overhanging end of the ulna. Indirect injury is, however, relatively common, and forms 3½ per cent of all wrist injuries. Two forms may be distinguished :—

1. Injuries by Compression.—

a. Between the lower end of the ulna and the hamate in ulnar deviation of the hand (*Figs.* 242, 244, 245).

b. Between the pisiform and the ulna in dorsiflexion of the wrist.

FIG. 244.—Fracture of the body of the triquetrum by compression against the lower end of the ulna, associated with compound fracture of the radius.

c. Between the lower end of the radius and the hamate in ulnar deviation of the hand (*Fig.* 243).

These commonly occur in association, dorsiflexion and ulnar deviation of the hand resulting from falls on the extended hand.

2. Ligament Traction (Sprain) Fractures.—

a. Of the dorsal tubercle : (i) Distal ligaments ruptured (*Fig.* 246); (ii) Proximal ligaments ruptured.

b. Of the tuberosity (ulnar collateral ligament) (*see Fig.* 252).

These commonly result from falls with the wrist in palmar flexion, or the hand in radial deviation.

The last injury is comparable to fracture of the tuberosity of the navicular. The reason for its comparative infrequence is that ulnar deviation of the hand is much more common than radial deviation. We note that in our series of compression fractures of the triquetrum we have not had a single case of associated fracture of the tuberosity of the navicular, thus suggesting that dorsiflexion plays the most important part in their aetiology. Fracture of the tip of the ulnar styloid is never associated with fracture of the tuberosity of the triquetrum (except as the result of direct violence) as the ulnar collateral ligament can only yield at one or other extremity, and is rarely associated with other fractures.

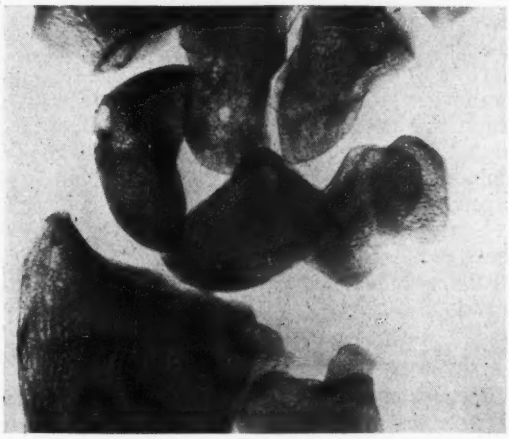

FIG. 245.—Compression fracture of the triquetrum against the ulnar styloid process, in association with anterior dislocation of the lunate. The wrist is under skeletal traction for reduction of the lunate.

FIG. 246.—Ligament traction fracture of the posterior tubercle of the triquetrum. Showing proximal tilt of the separated fragment.

RADIOLOGY

As in other injuries to the carpus, the successful recognition of the condition depends on taking oblique views in addition to the ordinary antero-posterior and lateral views. A slightly oblique view throws the shadow of the triquetrum a little above that of the lunate, and allows distinction to be made. The intact continuity of the posterior pole of the lunate is recognized in the lateral view, with the wrist midway between abduction and adduction, by the fine line of its compact layer throwing a hemispherical shadow which embraces the parallel curved shadow of the proximal pole of the navicular, at a distance of 1½–2 mm. If the compact layer of the lunate is seen to end short of the full curve of the navicular, then fracture of the posterior pole of the lunate is probable.

PHYSICAL SIGNS

These are few in cases of isolated fracture, and in cases of injury combined with damage to neighbouring structures are usually masked by those of the associated condition. The classical isolated fracture, that of the posterior tubercle, shows swelling localized to the ulnar side of the wrist, local tenderness maximal over the tubercle, and moderate pain on all movements of the wrist. Closer investigation of the movements shows radial deviation and palmar flexion of the wrist to be most painful. Distinction between this fracture and isolated fissure fractures of the body of the bone cannot be made clinically as in the case of the navicular. In compression injuries the physical signs are aggravated, and localization becomes impossible.

Compression Injuries.—These take the form of subperiosteal fissure fractures with little displacement, or areas of depression of cortex and lamellæ corresponding to the point of maximal pressure. Thus the indentation produced by the styloid process of the ulna can be readily recognized, or a fragment may be sheared off the proximal pole by the medial edge of the radius. (*Figs.* 243–245.) It is to be noted that in ulnar deviation of the hand the proximal surface of the hamate and the distal surface of the radius are parallel, thus allowing the triquetrum to be caught between them (*Fig.* 242).

In dorsiflexion the weight of the fall may be transmitted through the pisiform to the triquetrum, and this undoubtedly plays an important part in the causation of many compression fractures. The truth of this is vouched for by the occasional fracture of the pisiform which occurs in association with triquetral fractures, and that fissure fractures often radiate from the articular area of the pisiform. Denecke has also conducted experiments on the cadaver confirming this view. The association of these fractures with fracture of the styloid process of the ulna was also emphasized by the same writer, but it has not been common in our series of 60 cases, where it occurred only 3 times. In our opinion the styloid process of the ulna is more liable to fracture as a result of tension on the ulnar collateral and triangular ligaments than under compression, and all our cases of fracture of the ulnar styloid occurred in association with ligament traction injuries. Fracture of the ulnar styloid is, however, an authenticated complication, and we seem to have been unfortunate in only noting depression of the cortex of the triquetrum by the styloid process in our 11 cases due to compressional violence.

The fracture of the radial corner of the triquetrum (*Fig.* 243) has been suspected of being a ligament traction fracture. It does not correspond, however, to the attachment of the ligament between the lunate and the triquetrum, and this ligament is far too weak to produce it. The absence of fracture of this area of the triquetrum in dislocation of the lunate and in perilunar dislocations of the wrist bears this out. It is due to the impact of this corner of the bone against the medial edge of the radius, while the rest of the bone is cushioned by the triangular fibrocartilage (*Fig.* 242).

It is also possible for fracture of the posterior tubercle to occur from direct impact against the posterior margin of the radius (in gross ulnar deviation), as may be deduced from the occasional association of posterior marginal fracture of the radius, and the fact that the fracture is sometimes comminuted (*Fig.* 247). Inspection of the radiographs also suggests that the posterior edge of the proximal surface of the hamate may be in part responsible, and that the fractured posterior tubercle may be squeezed still further after temporary forward dislocation of the triquetrum.

Summary of Fractures associated with Compression Fractures of the Triquetrum.—

a. Posterior marginal fractures of the radius, with comminuted fractures of the tubercle.

b. Fractures of Colles type, altering the length of the radius: (1) Anterior dislocation of the lunate. (2) Fracture of the pisiform. (3) Fracture of the ulnar styloid (rare).

Mode of Injury	No. of Cases		Totals	Percentage
	Bonnin	Greening		
Compression	6 {a, 1; b, 2; c, 3}	5 {a, 1; b, 2; c, 2}	11	18
Ligament traction				
Tubercle	21	21	42	70
Tuberosity	5	2	7	12
Totals	32	28	60	100

Ligament Traction (Sprain) Fractures.—In radial deviation of the hand it can be seen (*Fig.* 252) that the change of position of the bone relative to both the radius and the ulna, and to the distal row of carpal bones encourages the development of these fractures. The more common ligament traction fractures occur in

excessive palmar flexion, the posterior tubercle of the triquetrum being separated by the pull of the ligaments from the body of the bone. Two sub-varieties may be noted, the fragment being tilted to look proximally or distally. This

The small flake of bone separated frequently remains ununited, and can be seen in the lateral view of the wrist, resembling a sesamoid in the extensor tendons. The organized lower surface of the flake enables it to be distinguished from

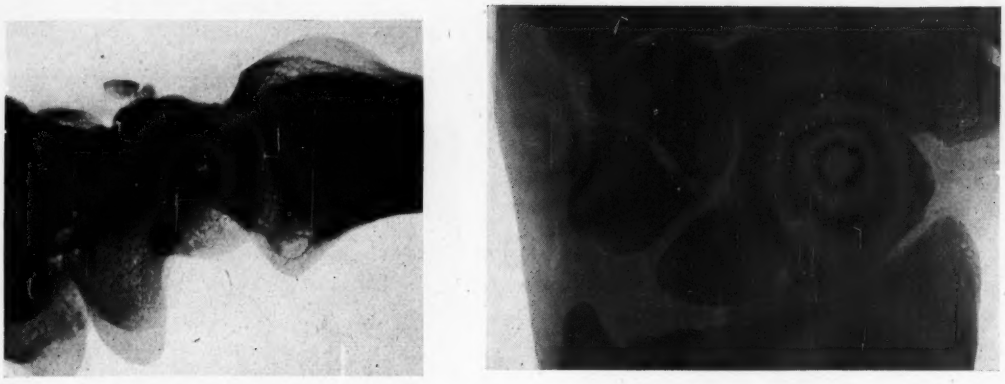

FIG. 247.—Comminuted fracture of the posterior tubercle of the triquetrum due to compression in dorsiflexion.

is probably dependent on whether the distal radiocarpal, or the proximal intercarpal ligaments rupture first (*Fig.* 246).

Most frequently the fragment is seen lying parallel with the dorsum of the carpus. Such a fragment has in most cases been separated by shearing strain. In palmar flexion of the wrist, the dorsal ligaments, being on the outside of the circle of the flexed carpus, tend to glide over the surface of the bones. This movement is hindered by the anchoring of the dorsal ligaments to the tubercle, which is consequently avulsed. A second possibility must however be borne in mind—the occasional volar subluxation of the triquetrum in dorsiflexion. This is usually accompanied by fissure fractures of the bone due to compression or comminution of the separated fragments of the tubercle previously described (*Fig.* 247).

FIG. 248.—Ligament traction fracture of the posterior tubercle of the triquetrum. Level fragment resembling a sesamoid. Old case.

a recent injury (*Fig.* 248). Separation of the posterior tubercle is associated with perilunar dislocation of the wrist, in which the proximal carpal row, with the exception of the lunate, and a small flake of the navicular is dislocated backwards, and puts an excessive strain on the posterior radio- and ulna-carpal ligaments, and on

FIG. 249.—Perilunar dislocation of the wrist showing fracture of the posterior tubercle of the triquetrum.

the ulnar collateral ligament. Fracture of the ulnar styloid process is commonly associated, and close inspection will show separation of the posterior tubercle of the triquetrum (*Figs.* 249).

Avulsion of the tubercle is also seen in association with the less common fracture of the posterior pole of the lunate (*Fig.* 250), again due to forced palmar flexion. Careful inspection will show loss of continuity of the line of the lunate and two lines of compact bone in the avulsed fragments. Avulsion of the posterior pole of the

lunate may be readily confused with fracture of the triquetral tubercle, but most text-books seem to make the opposite error. In *Fig.* 251 the dorsal fragment can be readily identified as coming from the volar dislocated lunate.

Fracture of the tuberosity of the triquetrum has already been shown to be rare. It is due to forced radial deviation of the wrist, and the ulnar collateral ligament which is responsible more frequently tears off the tip of the ulnar styloid process (*Fig.* 252).

FIG. 250.—Fracture of the posterior pole of the lunate and of the posterior tubercle of the triquetrum.

FIG. 251.—Fracture of the posterior pole of the lunate associated with volar dislocation of the lunate, which with or without dislocation may be mistaken for fracture of the triquetrum.

Summary of Fractures associated with fracture of the Posterior Tubercle.—

1. Marginal styloid fracture of the radius.
2. Colles's fracture.
3. Posterior marginal fracture of the radius (compression injury, often comminuted).
4. Fracture of the posterior pole of the lunate.
5. Fracture of the tip of the ulnar styloid (rare, indicating that radial deviation has occurred as well as palmar flexion).
6. Perilunar dislocation of the wrist, with fracture of the proximal pole of the navicular.

TREATMENT

Untreated cases are frequently diagnosed as 'chronic sprain', and the disability, though not gross, may be a permanent source of discomfort and necessitate the use of a wrist strap. The common occurrence of the ununited posterior tubercle in radiographs taken for other conditions indicates that in the majority of cases a complete functional recovery occurs in time. Experience shows that to avoid the first complication and to hasten recovery immobilization in plaster for a period of three weeks, with the wrist in the neutral position and the thumb unfixed, is fully justified. This is all that is necessary for ligament traction fractures. Such treatment is followed by complete recovery except for slight local tenderness, which may persist for months. Check radiographs show that clinical recovery may take place without union of the posterior fragment occurring in ligament traction fractures.

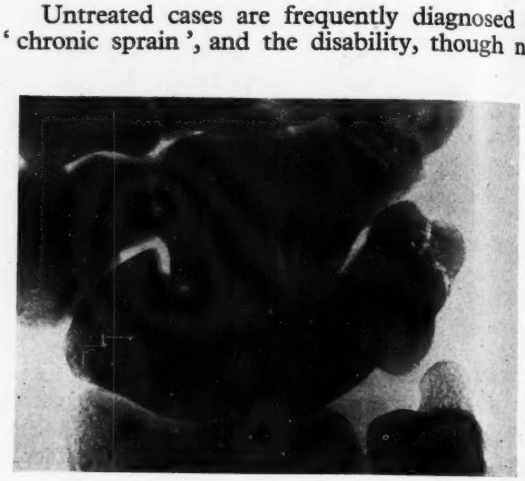

FIG. 252.—Fracture of the tuberosity of the triquetrum. Wrist in radial deviation.

In compression fractures of any severity the symptoms are usually sufficiently acute to demand the support of a plaster, and where this is so a longer period in plaster may be recommended. The length of time necessary for union is judged by the comparison of clinical and radiographic findings. The first radiograph is usually taken at the end of a month, and frequently shows satisfactory union. The slow union of fissure fractures as seen in the navicular does not seem to occur. If there is evidence of rarefaction at the fracture line and any persistence of marked local pain, a further fortnight in plaster is advised. At the end of this period all our cases have been satisfactorily united and have progressed favourably. No permanent disability has been seen following fissure fractures of the triquetrum alone, nor has any case of vascular disturbance

been seen in our series, nor are we familiar with any cases in the literature.

SUMMARY

1. Fractures of the triquetrum occur more commonly than is suspected (3½ per cent of all carpal fractures).

2. Radiological confusion with fractures of the posterior pole of the lunate is common, and points are discussed which enable a distinction to be made.

3. Fractures of the triquetrum fall into two main groups—those due to compression, and those due to ligament traction.

4. The commonly associated fractures are outlined.

5. Three weeks' immobilization in plaster results in complete clinical cure of ligament traction fractures, though radiologically the fracture may be ununited.

6. For compression fractures of any severity a longer period in plaster is recommended.

URETERAL STRICTURE WITH PERINEPHRIC URINARY EXTRAVASATION, CAUSED BY METASTASES FROM A SILENT CARCINOMA OF THE STOMACH

By JOHN DOUGLAS FERGUSSON

SURGEON, CENTRAL MIDDLESEX COUNTY HOSPITAL, LONDON

STRICTURE of the ureter due to secondary carcinomatous involvement is rare. In most of the recorded cases it has been caused by direct extension of a growth from a neighbouring organ—bladder, cervix uteri, cæcum, etc. Occasionally it has been brought about by encroachment of glandular metastases from a distant primary neoplasm, or by actual metastasis in the ureteric wall. Such instances have usually occurred in elderly subjects in whom the site of the primary growth was readily discernible, and the obstructive urinary symptoms obscured by the general manifestations of malignancy. The inconspicuous nature of the urinary disturbance may be comparable with that described by Randall and Campbell (1936) in cases of "silent renal death" accompanying malignant disease of the bladder with involvement of the ureteric orifice.

The present case is of interest on account of the age of the patient, the unobtrusive nature of the primary growth, and the presenting urinary signs of perirenal extravasation.

CASE REPORT

J. O'C., a male patient aged 39, was admitted complaining of severe continuous pain of insidious onset in the right loin for thirty-six hours. He vomited once at the time of admission, but complained of no other gastro-intestinal or urinary symptoms. There was no history of trauma and none of antecedent illness. Marked tenderness was apparent in the right costovertebral angle, but there was no evident swelling or œdema. No further abnormality in the abdomen or genitalia was detected apart from a mild degree of glandular hypospadias. An intermittent pyrexia rising to 100° was evident during the next few days. The symptoms and signs were suggestive of perinephric infection, and he received treatment with sulphapyridine while the following investigations were performed:—

Urine: Few leucocytes and epithelial cells. Free growth of *B. proteus* on culture.

Blood:
Leucocytes, 23,850.
Polymorphonuclears, 75 per cent.
Lymphocytes, 21 per cent.
Culture, sterile.
Urea, 40 mg. per 100 c.c.

While under observation tenderness in the right loin increased, and he developed signs of a small pleural effusion at the right base. This was confirmed by radiological examination, which, however, showed no elevation or depression of the diaphragm.

Intravenous pyelography showed a remarkable shadow on the affected side (*Fig.* 253), suggestive of extravasation of the opaque fluid from the inner and upper part of the renal pelvis into the perinephric space. There was also some blunting of the calices and evidence of hydronephrosis. The ureter was imperfectly visualized, but there was no sign of an opaque calculus in any part of its course.

Increased tenderness over the right kidney, and the development of psoas irritation, in conjunction with a further rise of temperature and pulse-rate, rendered exploration advisable. The perinephric space was approached through an incision in the right loin. Considerable œdema of the deeper tissues was encountered, and about 2 oz. of urinary fluid escaped from around the kidney. Examination of the kidney failed to reveal a suppurative focus or breach of surface, and no evidence of a calculus in the renal pelvis was detected. The wound was closed with drainage.

There was some improvement in the general condition of the patient after operation, and, with the amount of urinary fluid escaping diminished, drainage was discontinued. A few days later a further and persistent discharge of fluid took place from the wound, and was confirmed as urinary by its blue colour following the ingestion of methylene blue tablets by mouth.

Cystoscopy was performed to discover any cause for the suspected obstruction of the right ureter. The interior of the bladder proved normal, but no efflux was observed from the right ureteric orifice. A catheter passed up the right ureter impacted at a distance of 10 cm., and a second catheter inserted

beside it would progress no farther. Ascending pyelography with one catheter in this position showed a hydro-ureter extending down almost to the tip

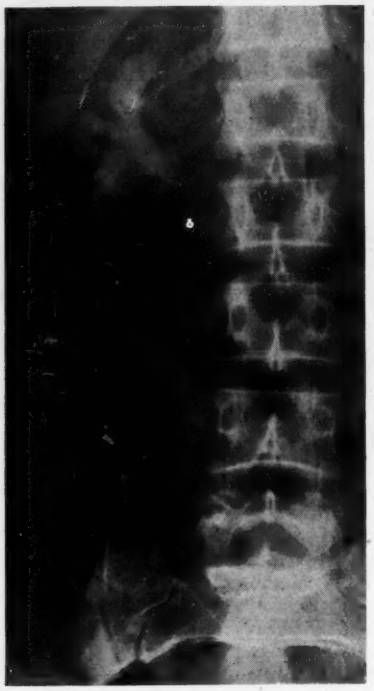

FIG. 253.—Intravenous pyelogram, taken fifteen minutes after injection, showing extravasation of opaque fluid from the inner and upper part of the renal pelvis.

of the catheter, at which point the lumen appeared to become constricted (*Fig.* 254).

AT OPERATION.—A week later, as there was no diminution of the urinary leakage, the right ureter

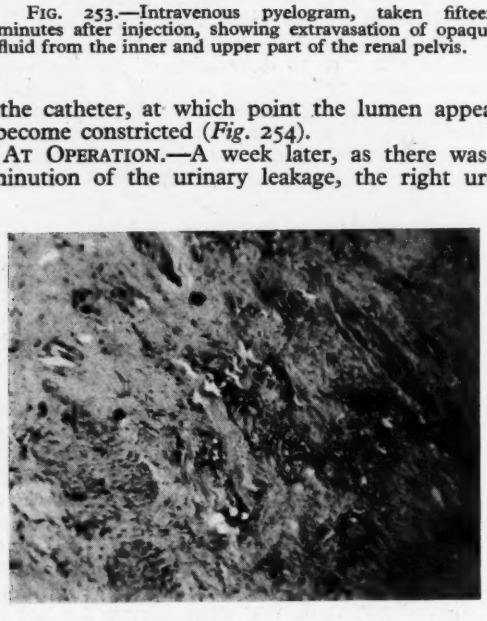

FIG. 255.—Microphotograph of affected portion of ureter removed at operation, showing cellular infiltration.

was exposed at the pelvic brim by a midline extraperitoneal approach, following the previous passage of a ureteric catheter up to the point of stricture. The ureter was found to disappear into a dense mass of enlarged glands just above the pelvic brim. The glands were considered as probably tuberculous, and involved the ureter for a distance of about 1 in. The ureter was dissected out of the mass with great difficulty, and appeared constricted and irregular.

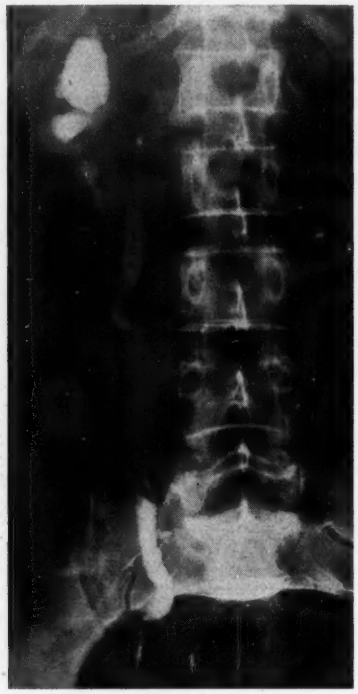

FIG. 254.—Ascending pyelogram, showing ureteric catheter passing up to site of stricture at pelvic brim, and hydronephrosis and hydro-ureter above.

Attempts to manipulate the ureteric catheter through the affected area met with no success, and a resection and anastomosis was performed. After excision of the strictured portion, the free ends of the divided

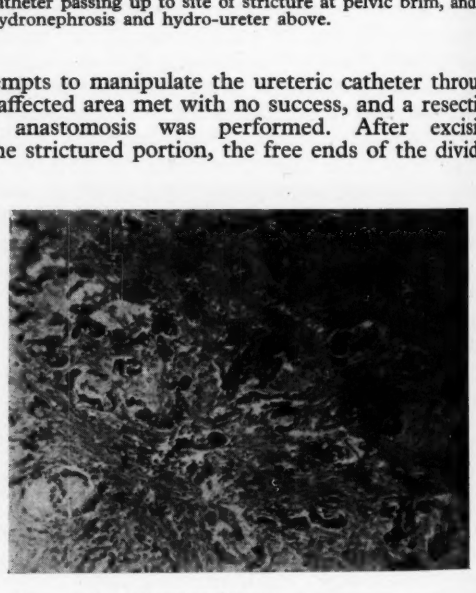

FIG. 256.—Microphotograph of stomach wall, showing infiltrating carcinoma of pylorus.

ureter were sectioned obliquely and anastomosed over the ureteric catheter. Immediately following operation all leakage from the loin ceased, and, after removal of the drain leading to the site of ureteric anastomosis, the midline incision healed.

Examination of the strictured portion of ureter

removed showed irregular narrowing of the lumen for a distance of ¾ in., which would admit a fine bristle only. Microscopical examination of the ureteric wall showed œdema with some cellular infiltration, thought to be inflammatory in character but in no way typical or specific (*Fig.* 255).

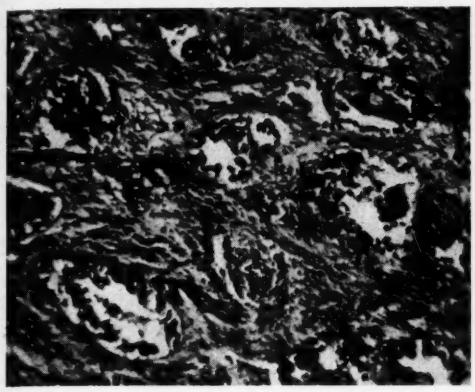

FIG. 257.—Microphotograph of para-ureteral gland adjacent to affected portion of ureter, showing infiltration by scirrhous carcinoma.

POST-OPERATIVE PROGRESS.—For a fortnight the patient progressed satisfactorily, passing a normal measure of urine per urethram, but at the end of this time his general condition deteriorated, and some urinary leakage from the abdominal incision occurred. This persisted and amounted in time to approximately half the total urinary measure, presumably representing the entire output from the right kidney leaking from the site of anastomosis. During the same period rapid emaciation set in, though no symptoms referable to the gastro-intestinal tract were in evidence apart from lack of appetite. He eventually died in an extremely wasted and enfeebled condition six weeks after the operation on the ureter.

POST-MORTEM EXAMINATION.—This showed a small, ulcerating primary carcinoma of the pyloric antrum (*Fig.* 256), with widespread secondary growths affecting the omentum and disseminated throughout the peritoneal cavity. The right ureter was involved in a neoplastic mass at the site of anastomosis above the pelvic brim. Microscopy of tissue removed from this region confirmed the malignant nature of the mass and invasion of the ureter (*Figs.* 257, 258). Above this the ureter was dilated, and examination of the kidney showed an area of extravasation spreading from the upper part of the renal pelvis and extending upwards and inwards between the kidney and the suprarenal gland (*Fig.* 259). Inflammatory changes were noted in the wall of the renal pelvis, but no evidence of neoplasm.

DISCUSSION

Attention has already been drawn to the paucity of recorded instances of carcinomatous metastases obstructing the ureter. Three cases were described by Carson (1925) in which metastases causing stricture had occurred, the primary growth affecting the prostate in two instances and the cervix uteri in the third. Eight cases, some arising from extra-urinary sites, are quoted by Hinman (1936) as being observed by Thomson-Walker and by Grauhan.

Giordano and Bumpus (1922) recorded a case of metastatic stricture at the uretero-pelvic junction in association with carcinoma of the prostate, and Thomas and Regnier (1924) reported a case showing involvement of the lymph-nodes,

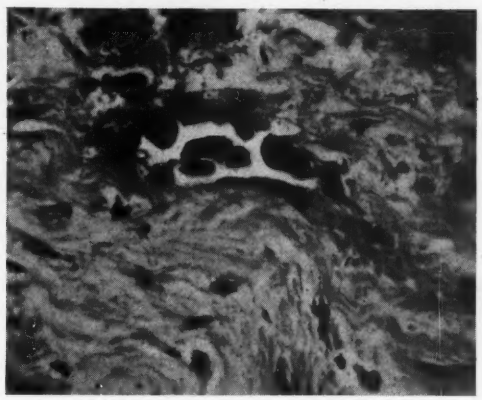

FIG. 258.—High-power microphotograph of ureteric wall, showing units of scirrhous carcinoma.

FIG. 259.—Photograph of right kidney, showing necrotic area between upper pole and suprarenal gland, into which extravasation had occurred.

psoas muscle, and right ureter by metastases from carcinoma of the bladder.

In some cases it is possible that the urinary condition passes unrecognized, or, if observed,

it is considered insignificant in view of the obviously declining state of the patient, and unworthy of record. When, however, it occurs in younger individuals it may assume greater importance, and presents two outstanding difficulties: First, the recognition of the obstruction as carcinomatous; and secondly, the decision whether any surgical interference is warranted.

In the case here recorded these problems were presented in the reverse order. The occurrence of an ingravescent perirenal extravasation rendered drainage imperative, and the persistence of a urinary fistula in the loin later demanded further investigation of the predisposing cause.

The presence of extravasation in the absence of trauma is unusual, though occasionally met with in infected hydronephrosis secondary to calculous obstruction, and more rarely in focal suppurative lesions of the kidney. The appearances shown in the intravenous pyelogram in the present case indicate that the extravasation occurred from the upper surface of the renal pelvis, an area seen to be affected by inflammatory changes on subsequent microscopy.

The continuance of the urinary discharge from the loin after exploration gave rise to the impression that the condition had arisen from the rupture of an infected hydronephrosis, probably caused by the impaction of a non-opaque calculus in the ureter. The operative findings showed the nature of the obstruction to have been incorrectly diagnosed, but added the further difficulty of determining the aetiology of the glandular enlargement. In the absence of any indication of malignancy and in view of the patient's age, the glands, though somewhat hard, were thought to be tuberculous. A similar condition of hydronephrosis brought about by the involvement of the lower ureter in a mass of tuberculous glands has been described in 3 cases by Hepburn (1918). The decision to perform resection and anastomosis of the ureter, after the unsuccessful attempt to manipulate the ureteric catheter through the affected portion, was certainly influenced by the false assumption that the glands were tuberculous. The true nature of the obstruction remained obscure until autopsy, though the rapid emaciation in the later stages gave rise to suspicions of malignancy, unconfirmed by repeated clinical examination.

SUMMARY

A case is recorded of a man aged 39, in whom right-sided perirenal urinary extravasation occurred as the result of an obstruction of the lower ureter by carcinomatous glands. The site of the primary growth in the stomach remained undetected until post-mortem examination.

Reference is made to a few reported cases of secondary involvement of the ureter by metastases from distant neoplasms, and mention made of the difficulties which may be encountered when malignancy is previously unsuspected.

I would like to express my thanks to Dr. W. Pagel and the staff of the pathological laboratory of the Central Middlesex County Hospital for their help in preparing the microscopical sections and photographs of the case.

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THE SURGICAL ASPECTS OF SULPHAPYRIDINE ANURIA

BY JAMES M. CAMPBELL, MAJOR, R.C.A.M.C.
FROM A CANADIAN GENERAL HOSPITAL

THE treatment of anuria following sulphapyridine therapy becomes more important as the use of the drug increases. This is especially true in Army practice where the drug may be given under circumstances in which exact supervision of the fluid balance is not possible.

Six cases of sulphapyridine anuria which did not respond to conservative treatment have been sent into this hospital within recent months. Five of these cases cleared on ureteric catheterization, and the one, which will be described in detail, was relieved only by renal surgery, after catheterization of the ureters was found to be impossible. The first procedure in early cases where the urinary output has stopped within the last few hours, is to give fluids intravenously together with diuretics in the hope that the anuria will be relieved. If the ureteric impaction is washed away by the diuresis this complication is overcome. However, except in very recent anuria, cystoscopy should be done at once, the ureters catheterized and the pelves washed out. There are also other indications for cystoscopy. If renal colic is severe and oliguria and hæmaturia are present, and if intravenous fluids plus diuretics do not increase the urinary output, the proper procedure in these cases is to attempt to relieve the ureters of the obstructive crystals. Some cases are seen in which cystoscopy is impossible, and here relief of the anuria by open surgery is

the only solution. This is the case in very narrow urethral strictures where the cystoscope cannot be introduced.

From the 5 cases that cleared on ureteric catheterization and pelvic lavage, two points appear :—

1. The follow-up of these cases by intravenous pyelography is interesting. One case showed no renal function on one side for ten days, and after that interval normal secretion returned. This delayed secretion from the opposite kidney was mentioned by Laird, in 1941. In the present series 1 case had a ten-day lag and another case which was operated on had no function on the opposite side for a period of eight days, and yet follow-up intravenous pyelograms and complete urologic investigation did not reveal any impairment of function. However, Newman and Shleser (1942) have described a renal calculus containing large quantities of sulphapyridine which required surgical removal two years after the use of the drug. This evidence suggests that a safe procedure would be to have intravenous pyelography done on these patients about a week following the relief of the anuria in order to have a proper follow-up on renal function.

2. The difficulties presented at cystoscopy varied according to the interval that elapsed from the beginning of the gross hæmaturia to the time of attempted ureteric catheterization for the relief of anuria. The case described in detail was that with the longest interval, and here the impaction at both the ureteric orifices was such that no catheter could be introduced in spite of repeated attempts. Complete ureteric impaction has been known to exist for some time. Smith and others reported in 1940 a case of sulphapyridine anuria in which the ureter mouths were blocked to such a degree that ureteric catheterization was impossible. This case was successfully treated by bilateral pyelostomy, decapsulation, and retrograde ureteric catheterization. A case has been described by Tsao and others (1939) where at post-mortem a probe could not be inserted into the ureteric orifices even under open vision. One feels that no time should be lost in relieving cases of sulphapyridine anuria. The cystoscopy can be done in almost all cases under local anæsthesia, and the importance of avoiding open renal surgery is such that early catheterization and pelvic lavage is indicated if a trial of a few hours on conservative treatment does not relieve the anuria.

DETAILS OF THE CASE REQUIRING SURGICAL AID

HISTORY.—The patient was a soldier, aged 24 years, who was treated for a cellulitis of the arm in a small field station. During the course of this treatment he received on four successive days the following doses of sulphapyridine : first day, 6 g. ; second day, 9 g. ; third day, 6 g. ; on the fourth day, 1 g. On the fourth day of the drug, gross hæmaturia occurred, and the drug was at once stopped. Fluids were forced. On the following day some right-sided colicky loin pain was complained of and the urine still showed gross blood. The third day following the commencement of hæmaturia the output of urine stopped and colic and aching pain persisted in both loins and in the suprapubic area. At this point he was transferred to hospital for further treatment.

ON EXAMINATION.—The soldier appeared to be in moderately severe pain. The pain was described as radiating from the back downwards on both sides, with some suprapubic pain as well. He was slightly drowsy. The blood-urea level was 110 mg. per cent. On catheterization, the bladder was empty except for a few drops of blood. Cystoscopy was done at once ; both ureter mouths were found to be solidly blocked with a mixture of clot and crystals. The ureteric orifices were stretched and œdematous from the continuous spasm on the obstructing crystalline mass. Numerous attempts were made at ureteric catheterization, but these were unsuccessful, although a few crystals were disengaged from the ureter mouths. The patient was then given intravenously a solution of 5 per cent glucose, morphia was administered, and he was allowed to rest the night. On the following day two further attempts were made at ureteric catheterization (one under general anæsthesia), but no progress could be made into the ureteric orifices. During the interval of attempted cystoscopic relief of the anuria, the patient developed increasing signs of uræmia and the blood-urea level just before operation was 140 mg. per cent. Following the last cystoscopy a right renal exploration was made under cyclopropane anæsthesia. The only reason the right side was chosen was because colic was more severe on this side than on the left.

OPERATION (Nov. 4, 1942).—The usual oblique incision was made and the kidney exposed. It appeared engorged ; the capsule was under definite tension, and its colour was a dark bluish-red. The pelvis and ureter were also markedly distended, œdematous, and under obvious pressure. An incision was made into the pelvis, and from it flowed a mixture of urine, blood, and crystals under pressure. The pelvis and upper ureter were emptied and at once the output of urine increased ; a 26-F. catheter was tied into the pyelotomy incision and urine began to drip in increasing amounts from the catheter. This obvious relief of the anuric state was thought to be adequate, considering the fluid nature of the contents of the pelvis, and the incision was closed in the usual manner around the pyelostomy catheter.

PROGRESS.—The urinary output from the loin catheter was enormous, 5530 c.c. draining in twenty-four hours. This continued and the patient rapidly improved. On the seventh post-operative day, the patient's condition was so satisfactory that cystoscopy could be done under local anæsthesia. At this time there had been a period of eight days during which the patient had passed no urine per urethram. During the last seven of these days the urinary output had been entirely through the pyelostomy tube. Cystoscopy was done on Nov. 11 ; the appearance of the ureter mouths was very different from that observed before operation. (Each post-operative day the bladder had been washed out with water and a small amount of fluid was left in the bladder ; this may have had some effect in carrying into solution the crystals at the ureteric orifices.) In any event the ureters had been able to disengage themselves of the firm calculus impaction and catheters were placed up both sides without much difficulty and lavage was carried out. Following this procedure urine appeared in the bladder and was voided for the first time in eight days. The next day the pyelostomy tube was removed from the loin and the urinary fistula put out smaller amounts

each day during the following three days. After the third day no urine leaked from the fistula and it healed rapidly. The patient improved markedly, and on Nov. 14 the blood-urea level was 36 mg. per cent. Intravenous pyelograms taken on the same day showed normal secretion on both sides. The further post-operative course was uneventful.

DISCUSSION

The following points seem to be most important in treating this type of anuria :—

1. The degree of ureteric impaction is a factor that must be kept in mind throughout the treatment of the renal complications of the sulphonamide drugs. The nature of the crystalline impaction and the consequent difficulties in catheterization vary directly with the interval that elapses from the time the gross hæmaturia began.

2. Cases of sulphapyridine anuria should be catheterized early if they do not respond after a few hours on routine conservative measures. Also oliguria, hæmaturia, and renal colic should be dealt with in a similar fashion if they do not respond within a short period to intravenous fluids and diuretics.

3. The obstruction may become such that ureteric catheterization is impossible and relief by renal operation must be carried out. Cases which cannot be relieved by cystoscopic methods should be treated by pyelostomy or nephrostomy. One-sided operation is adequate if the pelvic contents are fluid, for in these cases the likelihood is that the ureters can be catheterized in a few days after the relief of the anuria, due to the ability of the lower ureters to disengage themselves of a large amount of the crystals over a period of a few days.

4. Bilateral pyelostomy or nephrostomy and decapsulation would be chosen only in the very delayed type of case where at operation no secretion follows the emptying of the pelvis.

5. A follow-up with intravenous pyelography is important.

SUMMARY

1. The conclusions from the treatment of 6 cases of sulphapyridine anuria have been reviewed. One of these which required pyelostomy has been described in detail.

2. Three types of therapy are possible: (*a*) Intravenous fluids and diuretics; (*b*) Relief of the anuria by ureteric catheterization; (*c*) Where this is impossible, renal surgery.

3. The efficiency of each of these three lines of treatment depends on the time interval that has elapsed following the commencement of gross hæmaturia.

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POST-OPERATIVE RESPIRATORY COMPLICATIONS FOLLOWING UNILATERAL INGUINAL HERNIORRHAPHY IN WAR TIME

A STUDY OF 438 SERVICE CASES

BY B. G. B. LUCAS

SQUADRON-LEADER; ANÆSTHETIC SPECIALIST, R.A.F.V.R.

DURING the first year of war it was noticed that the percentage of post-operative respiratory complications following inguinal herniorrhaphy appeared very high. This has been commented upon by Binning (1940). The aim of this investigation was to verify this fact, and to try to find out the cause, and, if possible, to reduce the number of these complications. Most of them are of a mild character, not sufficient to interfere seriously with the convalescent period, but enough, nevertheless, to make life extremely uncomfortable for the patient.

Initially, it was thought unlikely that the percentage of post-operative complications was any higher in war time than in peace; rather that attention had been focused on these complications owing to the increase in the number of cases in war time. In peace time the operation of inguinal herniorrhaphy was done, more often than not, on middle-aged or old people, and such cases were nearly always swamped, from a statistical point of view, by more serious operations. Such figures as were obtainable gave results of 1·7 per cent (Mayo and Hardwick, 1936), 2·7 per cent (Fallis, 1936), and 6·2 per cent (Ferguson and La Towsky, 1941). These, however, were all classified as pneumonia, and so were probably severe in character. Beekman and Sullivan (1939) record a respiratory morbidity following herniorrhaphy of 13·6 per cent, of which only 3·5 per cent were severe. Finally, King (1933) gives a comprehensive figure of 14 per cent. None of these seemed to fit in with the clinical impression of the results obtained in war time, because no mention is made of the minor post-operative 'chests' which appear so frequently.

For the purpose of this investigation, post-operative chests were divided into four groups: The first were those who complained of a cough for the first forty-eight hours following operation, but did not expectorate or have any other clinical signs except occasionally a temperature of 99° F. The second were those who had mild clinical signs in the chest, with sputum, and a temperature of up to 100° F., but which cleared up within three days of the operation. The third group were classed as moderate; they were those whose chests lasted between three and five days. Finally, there were those who had a chest longer than five days.

Throughout this investigation the type of operation was the same. It was the so-called McArthur repair, in which a strip of external oblique fascia is used to repair the inguinal canal. The average operating time was forty-five minutes. Unless otherwise stated, the premedication used on all patients was omnopon (gr. $\frac{1}{3}$) with scopolamine (gr. $\frac{1}{150}$) given one hour before operation.

The first series that was analysed was operated upon under general anæsthesia with an induction of pentothal 0·5 g., followed by nitrous oxide, oxygen, and ether, using a Boyle's apparatus. The results of this were as follows: Cough, 10·5 per cent; slight chest, 20·0 per cent; moderate, 16·5 per cent; and severe, 14·1 per cent. Total cases 85 (*Table I*).

Table I.—HERNIORRHAPHY. FIRST SERIES, USING PENTOTHAL, GAS, OXYGEN, AND ETHER ANÆSTHESIA

	Number of Cases	*Percentage*
Nil	33	39·9
Cough	9	10·5
Slight	17	20·0
Moderate	14	16·5
Severe	12	14·1
Total	85	100·0

These figures seemed extraordinarily high. To verify the statement that ether is not a factor in post-operative respiratory complications (Sircar and Boston, 1940), a number of cases were done under pentothal, 0·5 g., followed by nitrous oxide and oxygen only. The figures for this series were: Cough, 10·2 per cent; slight chest, 20·3 per cent; moderate, 8·1 per cent; and severe, 8·1 per cent. Total number of cases, 69 (*Table II*). This was slightly better than the

Table II.—HERNIORRHAPHY. SECOND SERIES, USING PENTOTHAL, GAS AND OXYGEN ANÆSTHESIA

	Number of Cases	*Percentage*
Nil	36	53·3
Cough	7	10·2
Slight	14	20·3
Moderate	6	8·1
Severe	6	8·1
Total	69	100·0

ether series (Series 1), but although the number of moderate and severe chests was slightly reduced, that of the mild ones remained unaltered.

It was considered that the degree of hypoventilation immediately following operation might be a factor in the production of these mild chests. An attempt was therefore made to rouse the patients as they left the operating table. This was done by injecting coramine (Ciba) intravenously at the close of the operation until the patient was completely conscious, hyperpnœic, and extremely restless. The anæsthesia used was similar to Series 2, i.e., pentothal, gas and oxygen. This showed great promise, as the results were: Cough, 10·8 per cent; mild chests, 8·1 per cent; moderate, 5·4 per cent; and severe, 2·7 per cent. Total cases, 37 (*Table III*).

Table III.—HERNIORRHAPHY. THIRD SERIES, USING PENTOTHAL, GAS AND OXYGEN ANÆSTHESIA (WITH CORAMINE)

	Number of Cases	*Percentage*
Nil	27	73·0
Cough	4	10·8
Slight	3	8·1
Moderate	2	5·4
Severe	1	2·7
Total	37	100·0

Unfortunately this technique had to be abandoned because of two grave disadvantages. The marked rise of blood-pressure caused by the coramine was responsible for a number of small hæmatomata of the wounds. Secondly, the question of nursing these extremely restless patients during the first four hours became a very difficult one.

This diminution in post-operative morbidity, however, pointed very definitely to hypoventilation being an important factor. This was in agreement with Dawkins (1936), who proved that basal narcosis caused an increase in post-operative respiratory complications. At the same time, the abolition of ether seemed to bring about some improvement. Accordingly, a fourth series was done under local anæsthesia. The method chosen was a regional nerve-block injected in the area between the lowest costal margin and the superior iliac crest. This, rather than infiltration near the operation site, was selected for two reasons: Local infiltration distorts the anatomy of the region and predisposes to infection; and regional anæsthesia can be carried out by the anæsthetist and not by the surgeon, so saving time. One per cent novocain was used. During the operation pentothal was given intermittently to keep the patient unconscious. It was felt that local anæsthesia alone, without some heavy premedication, was not ideal from a psychological point of view, and although omnopon (gr. $\frac{1}{3}$) and scopolamine (gr. $\frac{1}{150}$) does produce some mental dullness, it does not achieve amnesia in the great majority of cases.

The results can be seen in *Table IV*. Of 68 cases 13·2 per cent coughed; 8·8 per cent had slight chests; 10·2 per cent moderate; and 11·4 per cent severe ones. This, then, appeared an unsatisfactory method, as the results were only slightly better than those under general

anæsthesia. Admittedly, the cough and mild cases were slightly less, but the number with no complications at all was roughly the same, 56 per cent as opposed to 53 per cent, but the number of moderate and severe chests was higher than with pentothal, gas and oxygen.

Table IV.—HERNIORRHAPHY. FOURTH SERIES, USING LOCAL AND PENTOTHAL ANÆSTHESIA

	Number of Cases	*Percentage*
Nil	38	56·0
Cough	9	13·2
Slight	6	8·8
Moderate	7	10·2
Severe	8	11·8
Total	68	100·0

An effort was now made to find some more suitable premedication in place of the pentothal with the local anæsthesia, so that the patient, while being comfortable, and, if possible amnesic, would not be too depressed from a respiratory point of view during the operation. Various drugs were tried, but none was found to be completely satisfactory. The opiates and oral barbiturates in large doses caused too much respiratory depression, as did avertin or pentothal rectally, while oral barbiturates in small doses often caused excitement. Eventually chloral hydrate was chosen as it had less respiratory depression than any other drug, but with omnopon and scopolamine produced very good amnesia. Two doses of 30 gr. were given, one the night before and the other three hours before operation.

The first series done with this method showed somewhat similar results to those with pentothal and local (*Table V*), but it was thought that the results might be improved if the patients could fully ventilate their lungs immediately following operation. Accordingly a system of pre-operative and post-operative breathing exercises was instituted. These exercises aimed at expanding the bases of the lungs, being modified from those originally described by MacMahon (1928). They were taught to the patient the day before operation, and his co-operation was

Table V.—HERNIORRHAPHY. FIFTH SERIES, LOCAL ANÆSTHESIA AND CHLORAL (WITHOUT EXERCISES)

	Number of Cases	*Percentage*
Nil	26	56·8
Cough	8	17·4
Slight	6	13·4
Moderate	1	2·9
Severe	5	10·9
Total	46	100·0

obtained as far as possible. Immediately on returning from the operating theatre the exercises were begun, and repeated, under supervision, every four hours, or more often if necessary for the first forty-eight hours. After this time they were done twice daily with the addition of abdominal and leg exercises to maintain the general tone of the muscles of the body.

This method has so far given the best results, and has effected a reduction in the number of post-operative respiratory complications, as will be seen from *Table VI*. Total number of cases, 87; of these 11·2 per cent coughed, 6·9 per cent had mild chests, 6·9 per cent moderate, and 6·0 per cent severe.

Spinal anæsthesia was not used at all for any series of cases as it was considered that the post-operative complications such as headache, backache, etc., would outweigh any advantages there might be in the case of its administration. Also the general opinion at present (Beekman and Sullivan, 1939; King, 1933; and others) is that the respiratory complications of spinal anæsthesia are as high if not higher than those occurring following any other form of anæsthesia.

While doing the series under local and pentothal it was noted that most of the chest complications occurred mainly on the same side

Table VI.—HERNIORRHAPHY. SIXTH SERIES, LOCAL ANÆSTHESIA AND CHLORAL (WITH EXERCISES)

	Number of Cases	*Percentage*
Nil	60	69·0
Cough	10	11·2
Slight	6	6·9
Moderate	6	6·9
Severe	5	6·0
Total	87	100·0

as the operation. Accordingly a number of cases (14) were screened radiologically four hours after operation. Unfortunately, owing to the small number of cases screened, due to technical difficulties in screening patients so soon after operation, no definite results could be obtained, but in all cases there was a definite diminution in diaphragmatic movement on the operated side. Of the 14 cases 1 developed a moderate chest and 3 developed slight ones. These findings have recently been confirmed by Bird, Kilner, and Martin (1943).

This diminution in diaphragmatic movement probably was partly responsible for the number of cases of atelectasis which occurred. Of the 70 cases of moderate and severe chests in the Series 1, 2, 4, 5, and 6, approximately only one-third (22 cases) had a simple bronchitis. There were 19 cases of lobar collapse, and the remainder (29 cases) showed scattered areas of atelectasis which radiologically resembled bronchiolitis. These two latter conditions responded extremely well to expansion therapy, i.e., breathing exercises and carbon-dioxide inhalations, but they did not respond well to chemotherapy. This conclusion has been reached not only from the study of these cases under review, but also from the observations of all the post-operative respiratory complications following other operations during the same period of time (two and a half years). Although chemotherapy will lower the temperature, the other signs and symptoms remain unaltered, and the average duration of the condition is more than doubled.

When all the cases were analysed it was found that those with a history of an upper respiratory

infection operated on within three weeks, had a higher incidence of post-operative respiratory morbidity. *Tables VII* and *VIII* compare two groups who had no history of upper respiratory infection, those under general anæsthesia and those under local. The figures in brackets are those for all cases irrespective of upper respiratory infections. It will be seen that the figures are definitely lowered as compared with previous ones. Needless to say, during the entire period under review, no case was operated upon which had an acute coryza, but towards the end of this investigation no case was done within three weeks of the disappearance of a cold no matter how slight. On the whole, the results have justified this decision.

Table VII.—Post-operative Results (all Operations) under General Anæsthesia (free from Colds)

	Number of Cases		*Percentages*	
Nil	67	69)	48·3	(44·8)
Cough	14	(16)	10·1	(10·4)
Slight	28	(31)	20·2	(20·1)
Moderate	17	(20)	12·2	(13·0)
Severe	13	(18)	9·2	(11·7)
Total	139	(154)	100·0	(100·0)

Table VII.—Post-operative Results (all Operations) under Local Anæsthesia (free from Colds)

	Number of Cases		*Percentages*	
Nil	72	(86)	73·4	(64·6)
Cough	12	(18)	12·3	(13·5)
Slight	4	(12)	4·1	(9·2)
Moderate	3	(7)	3·0	(5·2)
Severe	7	(10)	7·2	(7·5)
Total	98	(133)	100·0	(100·0)

Another fact which emerged was that there is a definite type of patient who will cough and get a chest post-operatively apart from those with a history of chronic lung conditions. These were the patients who were unco-operative, mentally dull, and rather miserable. This type was determined to be ill post-operatively, and refused all efforts to make them expand their lungs. They lay in bed breathing shallowly, would not move at all, and generally enjoyed ill health.

From this study it appeared that the main factors in the high incidence of respiratory complications following herniorrhaphy was the immediate post-operative hypoventilation. This was not thought to be due primarily to the method of anæsthesia, although general anæsthesia, particularly with ether, tended to aggravate the condition, but to the operation itself. The operation, because of pain or for some other reason, causes a diminution in movement of the diaphragm, with consequent hypoventilation. To see whether the partial fixation of the diaphragm was caused by sympathetic stimulation from the spermatic cord during operation, about 30 cases were done, some under general, some local anæsthesia, in which 10 c.c. of 2 per cent novocain was injected round the cord before it was handled to block any sympathetic impulses that might arise from this site. This, however, caused no alteration in the results whatsoever. All patients have difficulty in breathing deeply following herniorrhaphy due to pain at the operation site, and clearing of the throat or coughing becomes a very painful procedure. This allows mucus to settle in the lungs, with consequent blocking of the bronchioles.

SUMMARY

A tale of 438 cases of unilateral inguinal herniorrhaphies in Service patients have been studied from the point of view of post-operative respiratory complications. An anæsthetic technique is described which has produced the best results. Most of the respiratory complications are atelectatic in origin. The main factor in their causation is the hypoventilation immediately following operation. This is due primarily to the operation itself, not to the anæsthesia, but general anæsthesia, particularly with ether, tends to aggravate the condition. A history of upper respiratory infection within three weeks predisposes to respiratory complications. Such complications as occur are best treated by breathing exercises and carbon-dioxide therapy. The results of chemotherapy have been poor.

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EXPERIMENTAL SURGERY

HEALING OF EXPERIMENTAL WOUNDS OF LUNG*

By G. L. MONTGOMERY, Lieut.-Colonel, R.A.M.C.
ASSISTANT DIRECTOR OF PATHOLOGY OF A COMMAND

It has long been known that wounds of the lung are not fatal, and within recent years it has been possible to incise the lung surgically and to remove portions of lobes with satisfactory results. The inference is that wounds of lung heal, but little is recorded about the healing process. A search of literature has yielded only one paper (Olch and Ballon, 1929) on this subject. These workers made linear incisions in the lungs of dogs at right angles to the main axis of the lobe, and reported that the wounds healed as scars which did not differ materially from scars elsewhere in the body. The source of the scar tissue was not determined. It was noted, however, that phrenicotomy did not delay healing. In Maximow and Bloom's text-book of histology (1942) it is stated that "there is no evidence that the pulmonary tissue can regenerate after destruction," and this represents the prevailing opinion on the subject.

The present article records experimental work designed to study the process of healing of lung wounds and to observe the degree of regeneration of lung tissue which might occur; except in the most general way, no attempt was made to assess the rate of healing of the wounds.

EXPERIMENTAL METHOD

Seventeen adult cats were used, anæsthetized by intratracheal ether under positive-pressure anæsthesia, and thoracotomy was performed by resection of 2–3 cm. of the 7th rib on the left side in the axillary line, which exposed the upper part of the left lower lobe. The lower margin of this lobe was carefully withdrawn from the thorax on to gauze wrung out of hot saline, which was used also to pack the edges of the thoracotomy wound and prevent the lung from slipping back into the chest. With a pair of sharp Mayo scissors a triangular wedge of lung tissue, each side approximately 3 cm. long, was removed. In most instances there was considerable hæmorrhage from one or more large vessels, and when a bronchus was involved, the blood frothed from mixture with air. As a rule, this bleeding was controlled by one or more deep sutures of silk through the lung and tied firmly. In order that the tissues might not be crushed, clamping and ligation of vessels were avoided as far as possible; clamps for the wound margins were never employed. Thereafter the visceral pleural surfaces were carefully approximated by interrupted silk stitches, the lung returned to the chest, and the chest wall closed in layers after the pleural sac had been cleared of any fragments of blood- clot. As a rule, the operative procedure occupied 20 minutes.

The animals were killed at intervals between 36 hours and 115 days after operation. Usually death was induced by chloroform, but in some of the shorter experiments, the chest cavity was reopened first under positive-pressure ether anæsthesia to observe the movement of the lung. After death the lungs were expanded in the chest with intratracheal formol-saline, fixed for 48 hours in a large volume of this fluid, and blocks taken. These were treated with a saturated solution of mercuric chloride in saline for 24 hours, dehydrated, and embedded in paraffin wax *in vacuo*. Thick and thin sections were stained by hæmatoxylin and eosin, orcein and safranin, a modified picro-Mallory method, and impregnated with ammoniacal silver by Foot's method. Paraffin sections were stained also for iron pigment and frozen sections examined for fat by Scharlach R.

RESULTS

The cats recovered speedily from this procedure and seemed little upset. In animals killed within the first week the scars were clearly defined as dark hæmorrhagic bands protruding slightly above the pleural surface and surrounded by congested lung tissue, but later the result was a depressed or dimpled scar varying in colour with age from dark purple to light blue. As a rule, the scars within the first month were surrounded by a zone or halo of whitish pleura, and with two exceptions this was the limit of the pleural reaction. In these two animals, however, firm adhesions to the diaphragm and parietal pleura were present, and on consulting the operation protocols it is seen that in one of these cats ether vapour could be smelt and heard blowing from the lung after its return to the chest, while in the second the lung was noted to be unusually friable and the superficial stitches tore out easily.

Accordingly it may be said that excision of wedges of lung in cats results in depressed scars free from adhesions provided care is taken to appose the pleural surfaces reasonably accurately and to see that all bleeding is controlled before the lung is returned to the thorax.

Microscopical observations on the healing process may be described under two headings: (*a*) reconstitution of the continuity of the pleura; (*b*) regeneration of lung.

* From the Wilkie Surgical Research Laboratory, University of Edinburgh.

Reconstitution of the Continuity of the Pleura.—Normally the pleura of the cat consists of a single layer of serosal cells resting on an elastic membrane which is separated from the pulmonary alveoli by a thin band of collagen and reticulum fibres. In excising wedges of lung tissue, a corresponding portion of pleura was removed, and although the edges were approximated as neatly as possible, between the sutures small areas of lung tissue were left denuded of their serosa; these were speedily covered by fibrin. *Fig.* 260 is a low-power microphotograph of a wound 48 hours old, and it will be observed that the reaction is comparatively local and limited to the tissue around the wound. The centre is occupied by a dark, irregular mass of blood-clot, surrounded by collapsed or partially collapsed alveoli: strands of fibrin are present in the clot and extend over the pleural surface for a variable distance, covering and replacing the serosal cells. Even at this stage, however, there is a reaction on the part of the alveolar cells directed towards the re-formation of the pleural membrane over the raw areas.

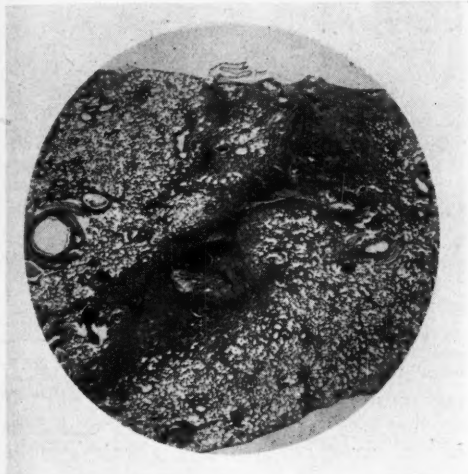

FIG. 260.—(Cat L5.) Wound 48 hours old, showing blood-clot and local reaction. H. and E. (× 4·5.)

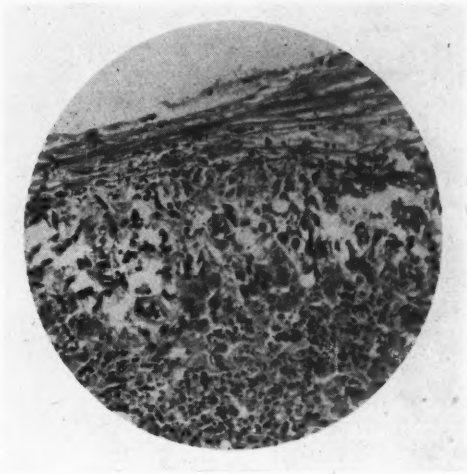

FIG. 261.—(Cat L5, 48 hours.) Subserous reaction at margin of wound. H. & E. (× 125.)

The pattern of this reaction can be seen most easily in the alveoli beneath the existing pleura at the margins of the wound (*Fig.* 261). In this region the surface alveoli are separated from the pleura by a subserous cellular zone of dilated capillary blood-vessels, newly-formed collagen fibrils, and spindle-shaped fibroblastic cells; mononuclear and macrophage cells are not numerous and pus cells are rare except in the immediate vicinity of the sutures. The superficial alveolar cells are swollen and hyperplastic, many have assumed cubical and polygonal shapes, and all have large vesicular nuclei with prominent nucleoli. So far as can be determined, it is the endothelium of the alveolar capillaries which has undergone this change and now is arranged irregularly in columns and sheets almost syncytial in character, but on the whole tending to form a delimiting barrier between the subserous cellular zone and the normal alveolar cells deeper in the lung. Many of the alveolar and subpleural capillaries have dilated and are lined by swollen endothelium. From these capillaries, as from the hyperplastic alveolar endothelium, spindle-shaped cells stretch out into the subserosa and augment its cellular content. There is thus at this stage, in the 48-hour wound, a subpleural vascular fibroblastic reaction derived from the surface alveoli of the lung.

In the early wounds the edges of the interrupted pleural elastic membrane are inverted for a varying distance into the wound, ending in an undulating or spiral fashion. Accompanying this inverted membrane on its pulmonary aspect there is an alveolar reaction similar to, and continuous with, that taking place in the subserous tissue of the lung surface. Deep to the termination of the elastica, however, the fibrin of the clot is at first in immediate contact with the torn alveolar tissue. In the 48-hour wound the reaction of the latter is intense dilatation of the capillaries of the collapsed or partially collapsed alveoli. These capillaries are packed with erythrocytes, while early hyperplastic changes, similar to those described for the subpleural endothelium, can be observed in their walls. From them also there develops a corresponding growth of spindle-shaped cells laying down collagen which ultimately, in a wound 10 days old, is seen as a dense layer of undulating fibres continuous with the newly-formed collagen in subserosa at the surface of the lung.

Coincidently with the subpleural reaction, there is a cellular reaction superficial or external to the limiting elastic membrane of the lung. It has been stated that the pleura for varying distances around the wound is largely denuded of serosal cells and covered by fibrin strands which

are continuous with the superficial fibrin clot of the wound itself. This material has a cellular content which is never rich and consists for the most part of mononuclear cells of the macrophage or lymphocytic type; pus cells are present in the vicinity of the sutures. A vigorous serosal-cell reaction, however, takes place at the periphery of the fibrin deposited on the pleural surface, or beneath that fibrin wherever surviving serosal cells remain. The latter proliferate rapidly and grow over and into the fibrin as sharply-staining polymorphous and spindle-shaped forms, many of them morphologically indistinguishable from fibroblasts, which take part in the organization of the surface fibrin (*Figs.* 262, 263). In this they are aided by small groups of cells of sub-pleural endothelial origin which can be seen to transgress the limiting membrane of the lung, especially where a dilated capillary abuts on the elastica.

The result of these proliferative processes is shown in *Fig.* 264, a microphotograph of an early dimpled scar in a wound 10 days old. This section has been stained by orcein and demonstrates the presence of a new elastic membrane in the external part of the collagen formed by the activity of the pulmonary endothelium. Initially this collagen takes the blue dye of Mallory's stain in the ordinary way, but in a wound 4 days old a refractile undulating line, continuous with the original pleural elastica and having an affinity for orcein, can be seen in the superficial margin of this collagen. This new elastic membrane

FIG. 262.—(Cat L1, 96 hours.) Serosal-cells growing over fibrin deposited on pleural surface. H. and E. (× 75.)

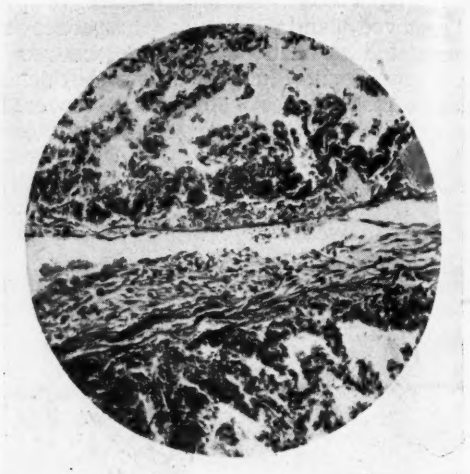

FIG. 263.—(Cat L1, 96 hours.) Serosal cell reaction to fibrin occupying indentation in superficies of wound. H. and E. (× 75.)

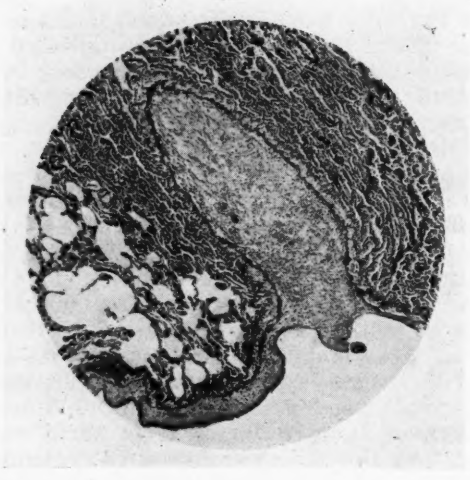

FIG. 264.—(Cat L2, 10 days.) Surface portion of wound showing re-formed pleural membrane. Orcein and safranin. (× 27.)

FIG. 265.—(Cat L2, 10 days.) High-power microphotograph of new pleural membrane to show dense collagen fibres separating pulmonary tissue (top right) from connective tissue (bottom left) of dimpled scar. Picro-Mallory method. (× 300.)

thickens, and in 10 days is connected by loop-like processes with the elastic fibres of the re-expanding marginal alveoli; the relationship of the elastic fibres to the collagen is shown in *Figs.* 265, 266. The new tissue can now be referred to as a fibro-elastic membrane and with ideal conditions, as in

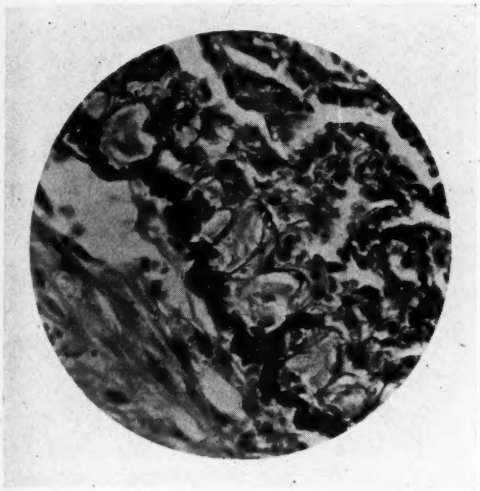

FIG. 266.—(Cat L2, 10 days.) Similar field to that in *Fig.* 265, to demonstrate arrangement of elastic fibres in the collagen. Orcein and safranin. (× 300.)

the example illustrated (*Fig.* 264), it unites with similar tissue entering the wound from other angles thus forming a continuous though dimpled new limiting membrane for the lung. On the other hand, in some animals the superficies of the wound was occupied by a firm clot which ultimately became almost hyaline, or by dense tissue in the shape of ligated blood-vessels or crushed bronchi. Under these circumstances the new fibro-elastic membrane, trailing off into the depths of the wound, had failed to unite with that of the other side (referring, of course, to the wound as though it were in one plane) by the time the animals were killed.

The tissue external to the new pleural membrane is derived from the serosal-cell reaction. It is less dense and more vascular than the subserous collagen; it is, in fact, vascular fibroblastic tissue rather than collagen. Over its surface grows a single layer of flattened serosal cells (*Fig.* 264) analogous to the growth of epithelium over a wound of skin, and by the contraction of the fibroblasts this new serosa is ultimately approximated with the reformed pleural elastic membrane. There is no evidence that the serosal layer, once formed, is reduplicated later.

Regeneration of Lung Tissue.—Evidence of regeneration of lung tissue can be seen at a very early stage in the healing of wounds, and it is probable that the process commences immediately after the traumatic stimulus. First in importance and most arresting in its microscopical appearance is the proliferative activity of the bronchi, with the formation of new out-growths from the parent stems. In the larger bronchi the earliest sign of this reaction is the development of cubical cells replacing the tall ciliated epithelium at one or more points in the lumen. This is succeeded by their appearance external to the membrana propria and subsequently

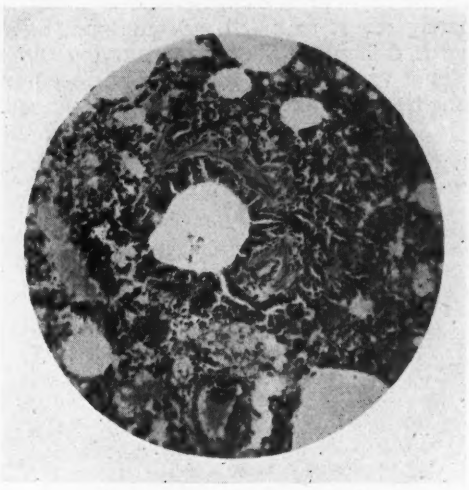

FIG. 267.—(Cat L5, 48 hours.) Bronchial budding at margin of wound. H. and E. (× 75.)

the formation of the bronchial buds is characteristically in the form of narrow channels of cubical epithelium; these appear always to be canalized; no solid columns were seen. As early as 2 days after operation this reaction can be

FIG. 268.—(Cat L4, 28 days.) Well-formed bronchial buds near apex of wound. H. and E. (× 42.)

observed both in the large and small bronchi around the wound. It is clear that the proliferative response is on the part of large and small bronchi simultaneously, and is limited by direction only: that is to say, the proliferation occurs on the aspect of the bronchus directed towards the wound. *Figs.* 267, 268 show the development

of bronchial buds at various stages: the former is from the margin of a 2-day wound and the latter from the apex of a wound 28 days old. As the wounds age, the bronchial buds increase in number, in size, and in the complexity of their structure in so far as their walls come to contain muscle-fibres and elastic tissue. With the expansion of the bronchi, the epithelial cells lining them ultimately revert to a tall ciliated type, but this change is difficult to detect in studying different wounds at varying ages. It does not occur until the lung has attained a high degree of regeneration.

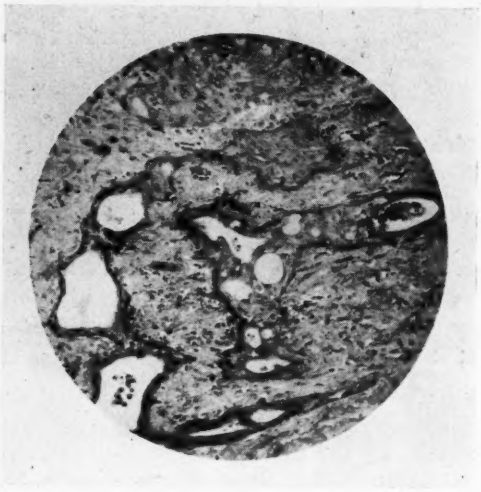

FIG. 269.—(Cat L13.) Bronchial buds lined by squamous epithelium. H. and E. (× 68.)

Although cubical epithelium may be said to be the characteristic lining of the proliferating bronchial channels, exceptions to this were seen. For example (*Fig.* 269), in a cat killed 51 days after operation, there is in the central part of the scar a dense collagenous area in which there are numerous bronchial buds lined by stratified squamous epithelium. Indeed the appearance of the squamous epithelium with its prickle cells is so striking that at first glance it suggests neoplasm. The metaplasia from the tall ciliated epithelium to a flattened type which ultimately becomes squamous can be observed in the constricted parts of the parent bronchus.

In addition to this major regenerative process on the part of the bronchial structures, there are subsidiary developments which are of importance. It will be recalled that bordering the immediately traumatized area or the blood-clot of the wound there are many collapsed alveoli, together with others whose definition is lost and whose capillaries have dilated to form a vascular barrier to the wound. Many of these collapsed alveoli expand as the wounds heal, and the appearance in a wound of several days' duration is of columns of alveolar cells arranged more or less parallel to one another, bordering linear air spaces and slanting towards the wound at angles which diminish from the surface to the apex. As has been pointed out above, in the central or apical portions of the scar there is frequently a fairly dense mass of collagen. This is especially likely to occur when a large bronchus or blood-vessel

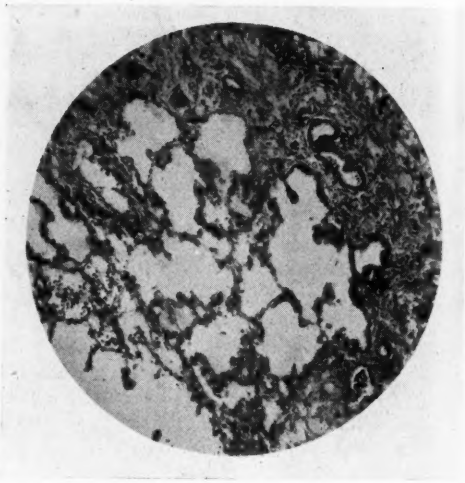

FIG. 270.—(Cat L17, 8 days.) Formation of new alveoli in margin of scar. H. and E. (× 68.)

has been ruptured in the infliction of the wound, because the main collagen of the normal lung is aggregated around these structures and in their rupture an excess of fibrin is liberated. There appears to be little doubt that a proportion of the

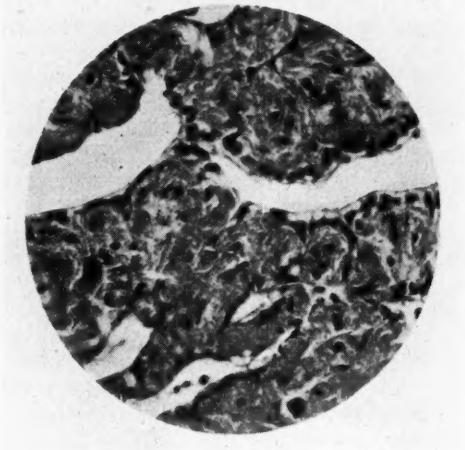

FIG. 271.—(Cat L17, 8 days.) Aeration of the scar: to show lining of new air spaces. H. and E. (× 300.)

fibrin is converted into collagen. However derived, the important point is that this tissue becomes aerated in special ways. Irregular slits develop in the collagen. Sometimes these appear to communicate with blood-vessels and contain red blood-cells; others clearly connect with bronchial buds and are lined by cubical epithelium or by elongated, flattened, and spindle-shaped

cells; others again communicate with alveoli and have a cubical epithelium. Not only is the collagen split internally into vascular and air spaces, but its margins are scalloped by new alveoli as by attrition. The alveoli which border lung. It is difficult to determine whether the epithelium of re-expanding alveoli becomes cubical or whether the presence of cubical epithelium always implies formation of new alveoli; the evidence favours the latter deduction.

FIG. 272.—(Cat L13, 51 days.) Formation of new alveoli in connective tissue beneath pleural membrane at surface of wound. H. and E. (× 68.)

or form in the margins of such tissue are lined by cubical epithelium in whole or in part; if the latter, it is the aspect in contact with the denser tissue which is cubical. Many photographs would be required to illustrate this process

FIG. 273.—(Cat L4, 28 days.) Cellular lining of new alveolus. H. and E. (× 300.)

adequately, but *Figs.* 270–272 give some indication of what occurs. Alveoli lined by cubical cells are common to all the regenerating wounds and are readily seen by reason of their regular arrangement and darkly-staining nuclei; *Fig.* 273 shows the typical appearance of the cells and incidentally emphasizes their resemblance to those of fœtal

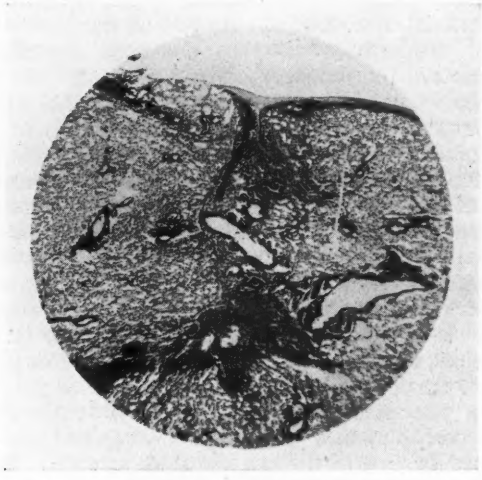

FIG. 274.—(Cat L4.) Wound 28 days old. Orcein and safranin. (× 4.)

It is in these various ways, then—by bronchial budding, by the expansion of collapsed alveoli, by the splitting of collagen, and the re-formation of alveoli—that the regeneration of lung develops and proceeds until the whole wound is aerated

FIG. 275.—(Cat L11.) Wound 115 days old, showing linear central scar and fine adhesion of the tip of the upper lobe to the original wound surface. Orcein and safranin. (× 5.)

and the scar reduced to a thin band of collagenous elastic tissue. *Fig.* 273 shows this process in a wound 28 days old, and *Fig.* 274, from an animal 115 days after operation, demonstrates the remarkable degree of regeneration which can be attained in the cat after excising a wedge of lung.

DISCUSSION

The Process of Repair.—First in importance in the healing of these experimental wounds of lung is the re-formation of the pleural limiting membrane, and, as has been described, this is brought about by the activity of the cells of the superficial alveoli of the lung. In this sense the term 'superficial' implies not only the alveoli which are immediately subpleural at the surface of the wound, but also those in its depths, which lie nearest to the clot; moreover, it frequently happens that the reaction affects only the aspect of the alveolus which is adjacent to the pleura or the clot. The result of this proliferative change is the production of hyperplastic cells which initially at least are all very much alike and which appear to originate in the capillary endothelium of the alveolar walls. Whether alveolar lining cells as such take part in this change it is not possible to say. It is true that in the sections of the normal cat's lung small flattened cells may be seen occasionally on the alveolar respiratory surfaces, but they are very scanty, and by far the major part of the normal alveolar wall is lined by the endothelium of the blood-capillaries. It is in keeping with the facts, therefore, to say that the proliferative response is on the part of the capillary endothelium, and although this does not exclude the possibility of the alveolar lining cells taking part, their numerical inferiority alone must limit their contribution.

There is a striking resemblance between the hyperplastic alveolar cells seen in an experimental wound 48 hours after operation and those described by Young (1928) following the intrapleural injection of bile-salts in liquid paraffin and of aqueous solutions of neutral salts of calcium, strontium, and aluminium. It will be recalled that in these experiments Young showed that the hyperplasia of the cells of the marginal alveoli of the lung could be produced in varying degrees by these agents, and that so far as neutral salts were concerned, increased in intensity proportionately with the valency of the cation. The reactions reached their maximum 48 to 72 hours after the injection, returning to normal within a few days. Young noted, however, that a small accidental trauma, whether situated superficially or more deeply, and any recent focus of necrosis, also results regularly on or before the third day in active proliferation of the surrounding epithelial and connective-tissue cells. So far as the present series of experimental wounds is concerned, there has been no microscopical evidence of necrosis, and although it is possible that the trauma alone may have caused the cellular hyperplasia, it is more probable that the stimulus has been the presence of fibrin. In support of this view are the facts that this change is shown by the alveoli (and portions of alveoli) nearest to the clot, and by those alveolar cells beneath the pleura to which a varying quantity of fibrin adheres. Further, the presence of this fibrin on the pleural surface has been seen to have a markedly stimulating effect on the serosal cells which have remained. Not only do those serosal cells undergo hyperplasia, but they also proliferate and grow over the fibrin tags in a fashion analogous to the growth of vascular endothelium over thrombus in a blood-vessel. Ultimately many of them assume spindle-shaped forms and take part in the organization and absorption of the fibrin.

The purpose of the activity of the alveolar endothelial cells is the formation of collagen and the ultimate restoration of the pleural membrane. Although, as pointed out by Maximow and Bloom (1942), there is some doubt as to the cytopoietic potency of endothelium in the adult mammal, these authors agree that in the later stages of inflammation and in tissue cultures endothelium often contributes to the formation of fibroblasts. In these experimental wounds of lung, all stages of transition can be seen between the proliferating endothelial cells and the spindle-shaped cells which are laying down collagen. There is no doubt that under the conditions obtaining in healing wounds, pulmonary endothelium develops into fibroblasts. Moreover, it is impossible to avoid the conclusion that the serosal cells of the pleura are endowed with similar powers. Under the stimulus of the deposition of fibrin on the pleural surface, the serosal cells can be seen to assume elongated and spindle-shaped forms, and are responsible for the looser fibroblastic tissue which is laid down external to the limiting membrane of the lung. Much of this tissue is ultimately absorbed, whereas that formed by the fibroblasts of alveolar origin beneath the new pleura is denser and persists longer. But this is a difference of degree only, and the conclusion is justified that at least under certain circumstances the alveolar endothelium and the pleural serosal cells are functionally similar.

A point of some theoretical importance is the method of re-formation of elastic tissue in the new pleural membrane. In these experiments, the essential observations are that the elastica develops in the newly-formed collagen barrier, on the external or distal surface of which it appears as a continuous, thin, highly-refractile wavy line, apparently acellular, and uniting with the divided ends of the elastic tissue of the original pleura. It is to be noted that from the beginning the re-formed elastica bears the same relationship to the newly-formed collagen as does the normal pleural elastic membrane to its thinner collagen layer. Although collagen formation is advanced in wounds 45 and 48 hours old, the elastic tissue was first identified after 96 hours. In the early stages individual wounds vary greatly, but from the evidence at present available, it may be said that the pleural elastic membrane appears to develop as a functional adaptation of collagen, a finding which is not out of place in an organ rich in fibro-elastic tissue.

The Mechanism of Regeneration.—No one can study the sections of those healing wounds and fail to be impressed by the intense activity directed by the lung towards the aeration of the scar tissue. It has been emphasized in the description of the process that the major factor is the formation of the new bronchial buds from the pre-existing bronchi. The process is analogous to the proliferation of bile-ducts in regeneration of liver, with the important difference that whereas in the lung the developing bronchi can, and do, become new alveoli, there is no evidence that bile-duct epithelium ever becomes functioning liver cells. Moreover, as soon as a new bronchial channel buds off from the parent trunk, it contains atmospheric air and is exposed to rhythmic variations in internal pressure. It is suggested that this is a factor of paramount importance in the regeneration process. Not only will additional penetrative power be transmitted through the bronchial buds in their longer axes, but their regular expansion and contraction will ease their passage through unexpanded lung and aid the splitting of the denser tissue. This is probably the reason why bronchial proliferation is projected only towards the wound. In other directions the bronchus is cushioned by intact alveoli containing air; the wound represents a collapsed area of lung where air resistance is much less.

There is no doubt that environment affects the structure of the bronchial epithelium, probably through limiting its movement. It was noticed repeatedly that when a bronchus was constricted in the margin of a wound, the respiratory epithelium of the stenosed part quickly reverted to a flattened and even a squamous type. In one animal the latter was observed as the sole bronchial lining when the bronchi penetrated unusually dense and hyaline collagen. Whether this epithelium would ultimately return to a ciliated type is doubtful, nor can its potentiality as the origin of a squamous-celled neoplasm be disregarded. This would appear to be a point of practical importance, as careful ligation of the larger bleeding points in excising wounds of lung will eliminate such dense collagen masses and accelerate the regenerative process. It was considered advisable, however, in the study of the experimental wounds to disturb the tissue as little as possible by ligatures and clamps.

Contrary to expectation, œdema was absent from all wounds older than 45 hours. In 2 animals killed by chloroform 36 and 45 hours after operation, congested alveolar capillaries were seen, with œdema of alveoli locally and of the peribronchial tissue some distance from the wound. Whether this is a regular accompaniment of the earliest wounds is not known at present.

In examining the wounds of animals killed several weeks after operation, it is observed that the amount of connective tissue diminishes with the increasing age of the wound. On the other hand, in pulmonary infections, as for instance in tuberculosis, absorption of scar tissue is minimal and indeed the aim of treatment is to stimulate its formation. What, then, is the explanation of the process in the healing wounds of lung? Two factors are suggested as possibly influencing this point. It is a truism that wounds heal in direct ratio to their blood-supply, and the healing wounds of lung were abundantly rich in blood. By contrast, chronic tuberculous lesions of lung show an ischæmia for which there are many well-known causes. Coupled with the fact that a pulmonary wound receives a rich supply of oxygenated blood, it must be borne in mind that lung tissue is in continuous movement. Probably no other wounded tissue is disturbed to such an extent. The effect of the atmospheric pressure transmitted by the bronchial buds has already been emphasized and the scar tissue may be visualized as experiencing the splitting effect of this, together with the regular expansion of alveoli on all sides, the impetus to the process of attrition described above. In addition to these expansive and contracting forces, the lung as a whole undergoes comparatively violent movements in the long axis of the thoracic cavity. Unfortunately in the two animals mentioned in the first part of this paper, in which adhesions to the parietal pleura had formed, the lung wounds were septic and the adhesions consisted largely of vascular granulation tissue enclosing small loculi of pus. These were therefore not comparable with the other non-adherent wounds. Nevertheless, from the experience of this experimental work, it is my opinion that in the healing of wounds of lung the active movement of the lung facilitates the absorption and aeration of the scar tissue.

SUMMARY

1. The excision of triangular wedges of lung tissue in adult cats was followed by subsequent healing with the formation of dimpled scars.

2. The processes of re-formation of the pleural membrane and of the regeneration of lung tissue are described.

3. The factors governing these processes are discussed.

It is with much pleasure that I acknowledge my indebtedness to Professor J. R. Learmonth for the generous hospitality of his Department and for his interest in this work; and to the staff of his Department for their technical help and for their assistance in the preparation of this paper. The expenses of the work were met by a grant from the Wilkie Surgical Research Fund.

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SHORT NOTES OF RARE OR OBSCURE CASES

A CASE OF POLYORCHIDISM

By Major R. S. HANDLEY, Specialist in Surgery, R.A.M.C.
and Major T. CRAWFORD, Specialist in Pathology, R.A.M.C.

Polyorchidism is so uncommon that the following example may be of interest.

CASE REPORT

History.—A private, aged 20, was sent to a Military Hospital because he complained of aching in the right testis after exercise. He had discovered a small lump in the testis, over which he was somewhat concerned and for which he sought advice. There was nothing of note in his past history.

On Examination.—A normally developed young man. Both testes and cords were normal except for a firm smooth mobile mass, about ¾ in. long and of oval shape, attached to the upper pole of the right epididymis. One medical officer had regarded this mass as an epididymal cyst, another as an encysted hydrocele of the cord, while we thought it was a tense cyst or a fibroma of the epididymis. It was decided that the blemish should be removed.

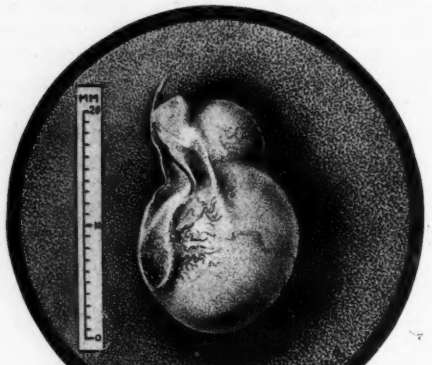

Fig. 276.—The specimen after removal.

At Operation.—A 1-in. inguino-scrotal incision was made and the cord pulled up. The tumour was felt within the cord at the upper pole of the epididymis and was easily shelled out of areolar tissue without opening the tunica vaginalis (*Fig.* 276). One small artery required ligature. The wound was repaired and the specimen sent over to the laboratory, uncut, with a diagnosis of 'fibroma of epididymis (?)'.

The Specimen.—The histological picture occasioned great surprise. The report read: "*Macroscopical appearance*: The tumour measures 2 cm. by 1 cm. Its outer surface is smooth and white and small venules are stretched across it. The cut surface is divided by a narrow white band into a smaller upper and a larger part, both of which are of pale yellow colour. *Microscopical appearance* (*Figs.* 277, 278): Section shows a miniature testis. There is a well-formed tunica albuginea but no tunica vaginalis, and a body and epididymis are present. The seminiferous tubules show an attempt at spermatogenesis, in some places reaching the spermatid stage. Other areas show hypoplasia similar to that seen in incompletely descended testes. Interstitial cells are present in normal proportions. The tubules of the epididymis are normal.'

Our recollection of the operation is that nothing resembling a small vas was cut: there was certainly no tunica vaginalis. But a minature vas might have been divided with the small artery already noted as requiring ligation (*Fig.* 279). Further clinical examination, after the diagnosis had been made, confirmed that the patient had two normal testes remaining, each with normal testicular sensation. The prostate was normal on rectal examination. There was no accentuation of the secondary sex characters.

Fig. 277.—Microphotograph of a longitudinal section of the complete specimen. (× 3.)

DISCUSSION

Boggon (1933) found only 11 histologically proven cases of polyorchidism in the literature, to which he added a further example. It seems that a single vas usually serves the double testis, but a double vas may be present. The extra testis is more often on the left side: it may show spermatogenesis. Boggon's own case was subjected to operation on account of torsion and histological section did not show spermatogenesis.

Jordan and Dodson's (1934) case showed a double mass on the left side, the upper part of which was considered to be a testis unconnected with a vas, while the lower proved on section to be composed only of epididymis. Atropy of a

testis connected with this epididymis was assumed to have followed an old injury to the scrotum: the upper mass, which was found in the inguinal canal, was fixed at operation in the scrotum and was thus not available for section. These authors

FIG. 278.—Microphotograph of the body of the testis. (× 75.)

draw an analogy between their case and an example of polyorchidism in a Rhode Island Red rooster which they were able to dissect.

H. H. Goldstein and A. R. Casilli (1939) describe a patient possessing three testicles, two of them on the right. The anatomical arrangements were somewhat obscured by a concomitant rhabdomyosarcoma.

Cranz (1942) removed a mass suspended in the peritoneum which he noticed while removing an acutely inflamed appendix. The mass proved on section to be a degenerate testis. The patient had two clinically normal testes in the scrotum.

A. E. Goldstein (1942) says: "The presence of an extra testicle is reported by Lamb, who collected reports of 23 cases and found that in addition to the extra testicle there was also an extra excretory apparatus". Lamb's paper was published in 1896 and none of the cases was proved histologically. It is, however, an interesting review of the subject from the dawn of medical writing to the end of the nineteenth century, and it is not quoted in the other papers to which we have referred.

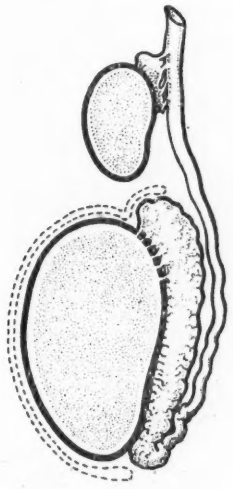

FIG. 279.—Diagram showing the position and probable connexions of the specimen to the right vas deferens.

SUMMARY

The presence of three testes in an apparently normal male is reported. The extra testis was on the right side and was small but of perfect architecture: it showed spermatogenesis.

We wish to thank Colonel W. Benson, C.B.E., D.S.O., for permission to publish the case, and Private Alexander, R.A.M.C., for the drawings.

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IRREDUCIBLE DOUBLE INTUSSUSCEPTION DUE TO MECKEL'S DIVERTICULUM COMPLICATED BY VOLVULUS*

BY C. W. CLARK, MAJOR, R.C.A.M.C.

THE unusual combination of a double intussusception of the ileum, produced by an invaginated Meckel's diverticulum, and complicated by a complete volvulus of the affected bowel, is of such rarity that it merits placing this case on record. Harkins (1933) reviewed 160 cases in the literature of intussusception due to invaginated Meckel's diverticulum. Miller and Wallace (1933) have reviewed 201 cases of Meckel's diverticulum from the literature and reported 40 cases of their own. Greenblatt et al. (1936) and Chaffin (1941) have each reported a number of cases of Meckel's diverticulum. None of these authors has reported the unusual combination found in this case.

* From the Surgical Division, a Canadian General Hospital, R.C.A.M.C.

CASE REPORT

HISTORY.—The patient, a soldier, aged 22 years, was admitted to hospital on Dec. 18, 1942. In the two months prior to admission he had suffered from three bouts of crampy, peri-umbilical pain unassociated with nausea or vomiting. These attacks had each subsided after one to two hours.

On Dec. 17, at 1 p.m., he developed crampy pain about the umbilicus which gradually moved towards the right lower quadrant. He vomited four times following the onset of the pain. His bowels had moved normally that morning.

FIG. 280.—Photograph of intussusception after resection. One hook is on the entering portion of bowel.

He was admitted to a Casualty Clearing Station about four hours after the onset of symptoms. Examination there revealed rebound tenderness in both lower quadrants. His leucocyte-count was 18,000, urinalysis was negative, and temperature and pulse were normal. On Dec. 18 his white-cell count was 16,300 and a flat plate of his abdomen was negative.

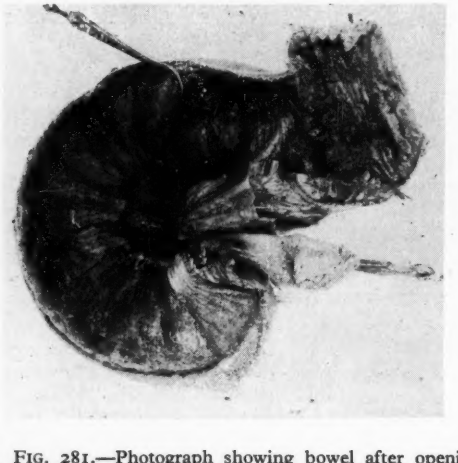

FIG. 281.—Photograph showing bowel after opening of ensheathing layer. The swollen end of the invaginated Meckel's diverticulum can be seen at the apex of the returning layer of the intussusception.

On admission to hospital at 5 p.m., Dec. 18, he was still obviously suffering pain, but had not vomited since the previous day. The abdomen was soft and flat, but there was definite tenderness in the right lower quadrant. Rectal examination was negative. His leucocyte-count was 19,700, with 96 per cent polymorphs. He was observed for two hours, when his temperature rose to 99·4° and his pulse to 96.

AT OPERATION.—At 8 p.m., Dec. 18, thirty-one hours after the onset of symptoms, the abdomen was opened under pentothal (0·5 g.) and cyclopropane anæsthesia. Free, turbid, somewhat brownish-coloured exudate was present in the peritoneal cavity. The appendix was atrophic. About 18 in. from the ileocæcal junction there was a volvulus of a loop of ileum, 15 in. long, through 360° in a clockwise direction. There was no adhesion present. The loop was bluish-black in colour. The volvulus was undone and it was found that an intussusception was present which was non-viable and irreducible. A firm mass could be palpated at the apex of the intussusception inside the ensheathing layer of ileum. This felt like a pedunculated adenoma through the bowel wall. Resection and side-to-side anastomosis was performed. Four grammes of triple sulphonamide powder (equal parts of sulphanilamide, sulphapyridine, and sulphathiazole) were placed in the abdomen. This powder was gently massaged about the resection until it was in the nature of a cream. The wound was closed with 2 g. of the powder in the layers of the abdominal wall.

FIG. 282.—Photograph showing appearance after opening of the outer three layers of ileum. The completely invaginated Meckel's diverticulum, with its associated intussusception inside the third layer, can be seen.

The convalescence was entirely uneventful and the wound healed by first intention. Nasal gastric suction was maintained for twenty-four hours. Intravenous glucose in saline was administered for forty-eight hours, and the blood-level of 5 mg. per cent was maintained for four days with intravenous soludagenan. There was no post-operative vomiting and he was out of bed in fourteen days. Two months after operation he was quite well and had no symptoms.

PATHOLOGICAL REPORT (Major L. P. Landsdown, R.C.A.M.C.).—The specimen consisted of a distended, blackish loop of small bowel 15 in. long, obviously an intussusception. At the proximal end of the loop

could be seen the entering portion of gut and near the distal end a firm mass could be felt through the bowel wall (*Fig.* 280). This mass felt like a pedunculated polyp. At each end about 1½ in. from the site of resection was a constriction which might well have been produced by a volvulus.

On opening the outer coat of bowel a good deal of hæmorrhagic fluid escaped and another gangrenous portion of bowel was revealed. This was the returning layer of the intussusception with its mucosal surface apposed to the mucosal surface of the outer or ensheathing layer (*Fig.* 281). Protruding from the distal end of this second layer was a firm rounded mass which looked very much like a ripe olive. The second layer was then incised and inside it was found a third or entering layer with its peritoneal surface apposed to the peritoneal surface of the second or returning layer described above.

This third layer was in turn opened throughout its length, and after doing so it was found to contain the stalk of the pedunculated, olive-shaped, mass about 4 in. long (a completely invaginated Meckel's diverticulum), which had apparently dragged inside the third layer an intussusception of 2 in. of ileum (*Fig.* 282). On incising the invaginated Meckel's diverticulum, its peritoneal surface could be traced right up to the olive-shaped tip.

There was, therefore, a double intussusception represented by: (1) An ensheathing layer; (2) A returning layer; (3) An entering layer; (4) A completely invaginated Meckel's diverticulum which had dragged behind it a 2-in.-long intussusception of ileum, inside the third layer.

Microscopical examination of sections from the mass considered to be a Meckel's diverticulum, showed the tissue to be extremely hæmorrhagic, with numerous dilated capillaries. However, an outer muscular longitudinal layer and a circular muscle layer could be identified with scattered imperfect glandular spaces. There was no doubt that the tissue was an anomalous portion of gut.

COMMENTS

A case of irreducible, double intussusception due to an invaginated Meckel's diverticulum, complicated by volvulus of the affected portion of bowel, is presented.

The Meckel's diverticulum apparently first became invaginated into the ileum, dragging behind it an intussusception of about 2 in. of small bowel. The swollen tip of the diverticulum then became caught by peristaltic waves in the bowel around it and became the apex of the main intussusception of the ileum.

The mechanism of the volvulus of the affected small bowel can only be explained as being due to excessive peristalsis attempting to push on the intussusception and causing the loop to revolve on its mesentery.

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BILATERAL CARCINOMA OF THE BREAST

By J. R. M. WHIGHAM

SURGEON, ST. ANDREW'S HOSPITAL, E.3

BILATERAL carcinoma of the breast is not without interest from the point of view of its comparative rarity (one in five hundred cases of carcinoma mammæ), and when met with the question of the nature of the origin of the second growth inevitably arises. Some light can occasionally be thrown on the subject by the influence that surgical removal has on the prognosis, by the existence or not, in the body, of other metastases (if this is a metastasis), and finally, but not the least important, by the histological findings. It is with points such as these in mind that a case which recently came under my care is considered worthy of description.

CASE REPORT

A woman, S. N., aged 74, presented herself on Dec. 14, 1942, because of an affection of both breasts. On the left side trouble had started three years ago with a reddening of the skin over the lower part; the breast had since become contracted. On the right a swelling had been noticed for three weeks, but now, for the last four days, the nipple had begun to bleed. In neither breast had the patient experienced any pain. The tumour on the left was hard and fixed, involving the skin and deeper structures; the nipple was drawn across towards the axilla and around its upper and outer edge there was an area of dry ulceration (*Fig.* 283). On the right a hard but mobile

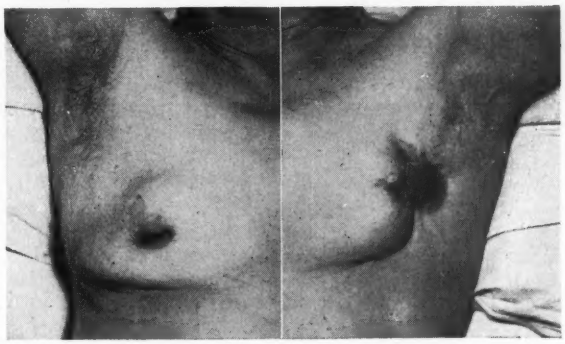

FIG. 283.—Photograph of a case of bilateral carcinoma of the breast.

swelling the size of a hen's egg was felt in the upper part of the breast, situated above the nipple, which was markedly retracted and from which there flowed a blood-stained discharge (*Fig.* 283). No enlarged lymphatic glands could be palpated in either axilla,

and no metastases in the lungs, spine, or ribs could be found by X-ray examination.

At operation the tumour on the right side was excised locally and a biopsy performed on the left. I have to thank Dr. A. B. Bratton for the histological report, which is as follows—

"Old and recent hæmorrhage in large solid acinar, tubulo-acinar, and occasionally papillary, polygonal-celled carcinoma of right breast.

"Trabecular and small solid acinar, polygonal-celled carcinoma of left breast."

He also adds this comment: "The tumour from the right breast gives one the idea that it may have arisen in a 'duct papilloma'. Though the tumours have grown in a different way, their cells are of exactly the same type, but this does not mean that they are not independent primaries."

The patient is the mother of eight children, the first five were fed on the left breast, the last three bottle fed. She had never nursed her babies on the right breast because of the retracted nipple.

Except for the possibility that an aunt died from cancer, there is no history of carcinoma in the family.

A NEW OPERATION FOR RESTORATION OF THE COMMON BILE-DUCT FOLLOWING ACCIDENTAL DAMAGE

By H. J. McCURRICH

HONORARY ASSISTANT SURGEON, ROYAL SUSSEX COUNTY HOSPITAL

THE repair of a severed or destroyed common bile-duct is an operation rarely necessary nowadays, largely owing to the insistence in the past by surgeons, among whom Moynihan was prominent, on the necessity for clearly seeing the Y-shaped junction of the cystic and common hepatic ducts to form the common bile-duct when carrying out the operation of cholecystectomy, and to the increasing practice of dissecting out the ducts before freeing the gall-bladder from the liver. When the opposite method is employed it is comparatively easy to drag upon the junction of the ducts so that the common hepatic duct at its termination, and the common bile-duct at its beginning, are drawn out and lying close together become mistaken for the continuation of the cystic duct and are so divided.

The classical operation for repair of the damaged common bile-duct was described by Sir James Walton (1915), but both it and its modification described by Moynihan (1926) are time-consuming plastic operations, requiring careful planning. dissection, and suturing. The operation about to be described was devised on the spur of the moment when dealing with a patient whose general condition prevented any prolonged procedure, and is here recorded in the hope that this may be of service to some colleague who may find himself in a similar predicament.

CASE REPORT

Mrs. A. H., aged 46, a married woman, was operated upon by her doctor on Oct. 20, 1942, on account of gall-stones. He removed the gall-bladder through a Kocher's incision parallel to the costal arch. Two drainage tubes were employed, one down to the right renal fossa, and the other down to the peritoneal suture line. There was only a slight discharge of bile, and both tubes were removed after forty-eight hours. On the third day she became very ill with abdominal pain, jaundice, bile in the urine, and slight discharge of bile from the wound. She became distended, and had nausea but did not vomit. Enemata failed to produce flatus. After a few days she improved somewhat, and passed some clay-coloured motions. I was then asked to see her. Although her doctor was convinced that he had not damaged the common bile-duct, there seemed to be no other explanation possible. It may be that the clamp had damaged the junction, as shown in the diagram inset in *Fig.* 284, and that the ducts had not been completely ligated, so that at first some bile passed, and that the narrow communication had given

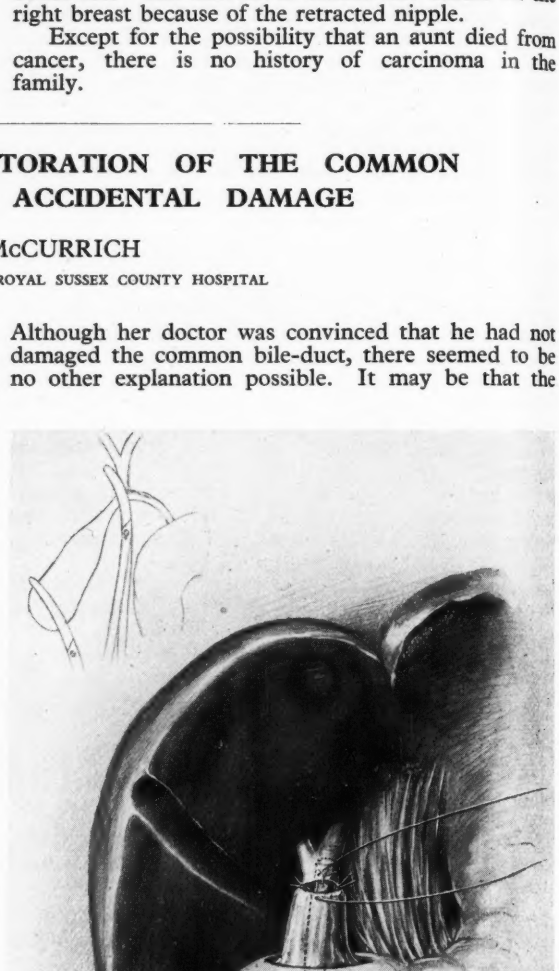

Fig. 284.—Showing the tube in the common hepatic duct and the anastomosis with the duodenal mucosa. *Inset*, showing how a clamp may damage the common bile-duct.

way when the drainage tube had been removed. Whatever the explanation, it was obvious that the patient was not passing bile normally, she was distended, and free fluid was present in the abdomen. She was very ill, but a laparotomy appeared to offer the only hope of saving her life. I therefore decided to operate.

OPERATION.—On Nov. 13 I opened the abdomen under general anæsthesia by a right paramedian incision. There was a considerable amount of free bile-stained fluid in the peritoneal cavity. About 2 pints of fluid were removed by suction. The omentum was swollen but compressed to form a thick flat mass of a greenish colour, the lobules of fat being flattened so that the appearance was that of a mosaic pavement. There was a lot of scarring round the foramen of Winslow, but I eventually found the cut end of the common hepatic duct. I was unable to find the common bile-duct. The patient's condition was causing anxiety, and it was essential that whatever was to be done should be done quickly.

There was a gap of about an inch between the duodenum and the end of the duct, and to bring the two together it would have been necessary to mobilize the duodenum. Even if one made a tube in the manner described by Walton, it might not reach without mobilizing the duodenum. I was unwilling to mobilize the duodenum as I did not want to incise the posterior peritoneum and expose the retroperitoneal tissues to the fluid in the peritoneal cavity, as this fluid was probably infected; nor did I think the patient would survive a lengthy plastic operation.

Every surgeon knows that, when performing an anastomosis on the stomach or duodenum, as soon as the serous and muscular layers are divided the mucosa on account of its folds appears to be redundant and pouts through the incision. I decided to make use of this experience, and I therefore inserted a rubber tube into the common hepatic duct of such a size that it fitted the duct easily, and secured it with a stitch, and then I incised the seromuscular coat of the first part of the duodenum by an incision about one inch long in the long axis of the gut near its upper border, and drew out a finger of unopened mucosa, and found it reached the end of the hepatic duct easily. I incised the apex of this finger, and inserted the free end of the rubber tube into it, so as to reach the main lumen of the duodenum. The cut edges of the mucosa were united to the cut end of the common hepatic duct by a few interrupted stitches of chromicized catgut. The accompanying sketch (*Fig.* 284) illustrates the method. No time was spent encasing the mucosal tube in any way, and it was hoped that it would become wrapped in omental and peritoneal adhesions, and so acquire an adventitious coat.

A drainage tube was inserted to the renal fossa, and the abdomen quickly closed.

AFTER-HISTORY.—The usual methods were used to combat shock; the jaundice disappeared, the wound healed, and the patient was progressing well when signs of infection appeared in the Kocher's incision accompanied by some jaundice. An abscess formed, and was incised; as it healed the jaundice disappeared, and the patient left hospital thirty days after the operation to restore her bile-passage.

In April of this year she developed another abscess in the Kocher's incision, associated with transient jaundice. After incision of the abscess the jaundice disappeared as on the previous occasion, and I surmise that it was catarrhal in origin.

She is now well (September, 1943) and doing her own housework and shopping, in itself a trying task for all housewives who have to cope with ration cards and reduced transport.

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A CASE OF TRAUMATIC PERFORATION OF THE GALL-BLADDER IN A CHILD OF THREE YEARS

BY. J. H. HICKS
SURGICAL REGISTRAR, GENERAL HOSPITAL, BIRMINGHAM

THE following case is believed to be unique.

CASE REPORT

HISTORY.—A boy, aged 3 years, was admitted with a history of his having fallen flat on his abdomen two days previously with no immediate ill effect. Twenty-four hours before admission abdominal pain had started.

ON EXAMINATION.—The child appeared febrile. The abdomen was slightly distended and there was generalized tenderness and rigidity, the latter signs being more marked on the right side. 'Release tenderness' was present. Temperature, 101·2°; pulse-rate, 132. No abnormality was discovered on rectal examination.

AT OPERATION.—On laparotomy, free bile, about 6 oz., and of a pale, opaque green appearance was found in the peritoneal cavity. There was slight hyperæmia of the intestines. Exploration revealed a greatly distended gall-bladder, purple and congested, and partly covered by adherent omentum. On separation of the adhesions a circular hole ¼ in. in diameter was found in the fundus and dark-green, clear bile began to leak through this aperture. Cholecystectomy was done, the gall-bladder being unusually adherent to its bed—there was no mesentery. The abdomen was closed, with a drain into Rutherford Morison's pouch.

Recovery was straightforward; there were no sequelæ up to the ninth week.

THE SPECIMEN.—The gall-bladder on detailed examination was found to be enlarged to about the size of a normal adult organ. It was plum-coloured and thin walled—so thin that in the region of the perforation it was translucent. There was no pus, fibrin, or necrotic tissue, and the perforation had clean-cut edges. The mucosa and the cystic lymph-gland were œdematous. There were no stones in the organ, nor in the small portion of the common bile-duct exposed during operation. Culture of the bile from the peritoneum proved sterile.

Professor G. Haswell Wilson has kindly given his opinion on the pathological findings. The wall of

the gall-bladder on section showed areas of hæmorrhage without any polymorph reaction, appearances consistent with recent trauma. Other parts of the section showed chronic catarrh of the mucous membrane and some round-cell infiltration suggesting a low-grade chronic cholecystitis unconnected with the recent changes.

COMMENT

It is probable that the fall caused injury to the gall-bladder with intramural hæmorrhage and a small area of necrosis due to local interference with the blood-supply, followed by perforation.

The only similar case found in the literature is recorded by Siegel (1909). In this, rupture occurred eight days after injury, and was explained as being a distension gangrene due to secondary infection when the cystic duct became occluded with blood-clot.

I am grateful to Mr. Baron T. Rose for permission to record this case.

REFERENCE

SIEGEL (1909), *Münch. med. Wschr.*, **99**, 341.

COMPRESSION OF THE EXTERNAL POPLITEAL NERVE BY A BAKER'S CYST

BY NORMAN WHALLEY

NEURO-SURGICAL UNIT, GENERAL HOSPITAL, NEWCASTLE UPON TYNE

THE external popliteal nerve is particularly exposed to trauma on the outer surface of the knee-joint, where it winds round the neck of the fibula in the superficial tissues. Here it may be injured by forces acting directly from the outside, but is also commonly contused or stretched in severe adduction injuries of the knee resulting in rupture of the lateral capsule, external lateral ligament, and detachment of the fibular styloid, or in complete dislocation of the joint (Platt). Neuromas and fibrosarcomas arising in the sheath of the nerve in this position, although rare, are well-known pathological entities. A condition, however, which is very rarely encountered is compression of the external popliteal nerve by a Baker's cyst. This paper is concerned with the description of such a case.

CASE REPORT

HISTORY.—A man, aged 37, was admitted to the neurosurgical unit of the General Hospital, Newcastle, on Aug. 13, 1942. About two weeks previously he had noticed a pain on the outer side of the left leg just below the knee. The pain was aching in character and radiated down the outside of the leg on to the dorsum of the foot as far as the big toe. One day, whilst walking, he had to sit down because of the severity of the pain, and on examining the leg he noticed that the ankle was weak. A few days before he was admitted to hospital the pain and weakness of the ankle became much more severe.

ON EXAMINATION.—There was very marked weakness of dorsiflexion of the left ankle-joint, this disability being obvious on walking, since the foot had to be lifted high off the ground to prevent stubbing of the toes. The left peroneal and anterior tibial muscle groups were wasted. On the outer side of the leg just behind the neck of the fibula, a small swelling could be palpated. It was tender to pressure, rubbery in consistency, and oval in shape, measuring 3 cm. × 1 cm. The skin moved freely over the swelling, which could be moved laterally but not along the line of the external popliteal nerve; its surface was smooth.

There was diminution of sensation over the outer surface of the leg and dorsum of the foot. The knee-joint showed no abnormality, either clinically or by radiography. There were no other swellings about the body and no organic disease of the central nervous system could be detected.

It was impossible to make a precise diagnosis, but the following conditions were considered: (1) Neurofibroma of the external popliteal nerve; (2) Fibrosarcoma of the external popliteal nerve; (3) Enlarged adventitious bursa; (4) Baker's cyst arising from the tibio-fibular joint.

AT OPERATION (Aug. 31) (Mr. G. F. Rowbotham).—The swelling was explored through an incision in the line of the external popliteal nerve. In the outer and lower part of the popliteal space the nerve was easily isolated and traced downwards to the upper pole of a rubbery swelling just below and outside the head of the fibula. At this point it lost its definition and it was impossible to tell whether the nerve dipped under, entered, or crossed over the superficial aspect of the swelling. Therefore the nerve was explored below the head of the fibula by splitting the fibres of the peroneus longus and traced upwards. It was then seen to be stretched over the swelling in the form of a thin sheet. With some difficulty the nerve-fibres were freed from the capsule of the swelling by sharp dissection and pulled aside with tapes. Unlike a neuroma, the swelling remained attached to deeper tissues by means of an elongated tail which was traced as far as the under surface of the superior tibio-fibular joint. Here its base was ligatured and cut across. It became clear that we were dealing either with a Baker's cyst or a ganglion. There was no demonstrable communication with the superior tibio-fibular joint. The swelling contained a thick glairy colourless fluid, the contents of neuromas usually having a yellowish tinge. It is well known that hernial protrusions of synovial membrane (Baker's cysts) if of long standing may become occluded at their proximal ends, the result being a cystic swelling connected to the joint line by a tail of fibrous tissue. This was the condition found at operation in this case.

PATHOLOGICAL REPORT.—Microscopically this has a hyaline fibrous wall and no obvious lining, epithelial

or endothelial. In the wall are three small portions of peripheral nerve, each surrounded by a good perineurium and more suggestive of a fortuitous incorporation in the wall than an indication that the cyst is of nervous origin. On the other hand, a hernial protrusion of synovial membrane (Baker's cyst) if of long standing could result in a microscopical picture as featureless as this one.

POST-OPERATIVE COURSE.—Shortly after the operation the paralysis of the ankle was more marked. To-day (August, 1943) the man can walk without any kind of mechanical aid and has returned to full duties.

SUMMARY

A Baker's cyst arising from the superior tibio-fibular joint is described, which enlarged to compress the external popliteal nerve and produce a foot-drop.

I wish to express my thanks to Mr. G. F. Rowbotham, under whose care the patient was admitted to hospital, for permission to publish this report.

SPONTANEOUS PERFORATION OF THE PELVIC COLON

BY JULIUS BROWN

SURGEON-IN-CHARGE, EMERGENCY HOSPITAL, WHITTINGHAM, NEAR PRESTON

ACUTE non-malignant perforations of the colon may be due to trauma acting on the bowel from without, causing crushing, tearing, or bursting of the wall of the gut. Considerable force is necessary to produce these effects. On the other hand, the bowel may perforate from causes acting from inside the lumen. According to Koucky and Beck (1940), the differential diagnosis in these cases lies between diverticulitis, foreign body, acute elevation of intracolonic pressure, proctoscopic (or sigmoidoscopic) examination, severe ulcerative colitis, or the ulcerative stage of tuberculous enterocolitis. Acute elevation of intracolonic pressure may be the result of compressed-air hose injury, high colonic flush, or even a simple enema.

CASE REPORT

HISTORY.—E. L., male, aged 30, was admitted to hospital on March 22, 1943, with the following history. On the day of admission he woke up at 7 a.m. feeling particularly well, lay in bed till 7.30 a.m. and then got up. A few minutes later, without apparent cause, he was seized with a very severe pain in the hypogastrium. The pain did not radiate and was so severe that he rolled about on the floor in agony. The bowels had opened normally on the previous day, and there was no urinary disturbance. He had never suffered from gastric symptoms. Shortly after admission to hospital, he vomited. His past history gave no relevant information.

ON EXAMINATION.—He was a young man of good physique, obviously in severe pain, with a cold clammy skin, and cyanosis of the lips and the lobes of the ears. Pulse 64, temperature 98°, respirations 18. The tongue was dry and furred, and respiration was thoracic. The abdomen presented a generalized board-like rigidity, with tenderness over the whole abdomen and no localizing signs. Liver dullness was normal, and no free fluid was detected, but examination for this was unsatisfactory because of the rigidity. The bladder was distended. Per rectum, a diffuse tenderness was present, and no other abnormality. B.P. 150/85.

The bladder was catheterized, 10 oz. of normal urine being withdrawn with a urinary diastase of 6·6 units. A diagnosis of diffuse peritonitis was made, and after treatment for shock, operation was performed eight hours after the onset of symptoms.

AT OPERATION.—Under gas, oxygen, and ether anæsthesia the abdomen was opened through a right paramedian incision. Much free thin purulent fluid was present in the peritoneal cavity, and coils of small intestine were found acutely inflamed and in some areas covered with plastic lymph. In the pelvis was a small quantity of fæces. On the antimesenteric border of the pelvic colon, close to the pelvirectal junction, there was a laceration in the long axis of the bowel wall, about 1 cm. long and with a mass of fæces protruding through it. The edges of the laceration were irregular, and the bowel wall, apart from the involvement in the general inflammation, was macroscopically normal.

No diverticulum was present in the neighbourhood and no foreign body was found. The regional lymph-glands were not enlarged. No other abnormality was found in the abdomen. The perforation was closed in three layers of sutures, and an appendix epiploica was tacked down over the suture line. The pelvis was cleared of fæces, local sulphanilamide powder was inserted, and the abdomen closed over a drainage tube. He was returned to the ward very ill, but soon rallied on intravenous infusions of plasma and saline. Sulphonamides were administered both intravenously and orally.

Convalescence was stormy, but he eventually made a good recovery, being discharged to a convalescent hospital with the wound healed on May 6. During convalescence, a barium enema revealed no evidence of diverticula or other abnormality in the colon. He repeatedly denied any knowledge of an ingested foreign body or any interference of any sort with the rectum. On Aug. 31, when he was last seen, mild obstructive symptoms were present, the wound was healed, and there was an incisional hernia, but he refused further operation. In other respects he was fit and well.

DISCUSSION

The onset of the illness resembled that of a perforated peptic ulcer, with the exception of the site of the pain, which was in the hypogastrium. Trauma was conspicuously absent as a causative factor, and we can therefore exclude the possibility of the rupture being due to force applied from without. Of the intraluminal causes, in

face of his stout denial of rectal interference, only two possibilities need be seriously considered—diverticulitis and foreign body. As no diverticulum was found at operation, and as radiography of the colon later showed no diverticula, this possibility must also be ruled out. Neither at operation nor later in the wound discharge or in the fæces was a foreign body recovered; the wound healed at a normal rate and had not broken down over five months later, the size of the perforation which would, if due to a foreign body, suggest that it would be a large one and easy to find, and the absence of local reaction around the margins of the laceration, all tend to exclude this factor. If we are to accept his denial of rectal interference, and I see no reason to do otherwise, I can offer no explanation of the cause of this condition. In a search of the literature, I have failed to find any reference to a similar case.

I am indebted to the Ministry of Health for permission to publish the notes on this case.

REFERENCE

KOUCKY, J., and BECK, W. C. (1940), *Surgery*, **7**, 674.

REVIEWS AND NOTICES OF BOOKS

Nasal Sinuses. An Anatomical and Clinical Consideration. By O. E. VAN ALYEA, M.D., Assistant Professor, Department of Laryngology, Rhinology, and Otology, University of Illinois College of Medicine, Chicago. 9 × 6 in. Pp. 262 + xii, with 82 illustrations, some coloured. 1942. Baltimore: The Williams and Wilkins Co. (London: Baillière, Tindall & Cox.) 36s. net.

THE author bases his experiences on anatomical studies and clinical observations made in the Departments of Anatomy and Otolaryngology in the University of Illinois.

His book consists of twelve chapters. The problems of each of the paranasal sinuses are discussed, as well as more general conditions, such as histopathology and allergy.

In the chapters on the air sinuses themselves, the origin and development are given first. The diagnosis of the various forms of infection is discussed, together with treatment. Special points in anatomy are described in great detail.

The book is full of important information and gives a useful introduction to the literature already accumulated on sinusitis.

The mistake the author has made is that he has not clearly written either for the established specialists or for those who are just beginning to take a particular interest in the subject.

The book is beautifully produced and the diagrams are excellent.

Fractures and Joint Injuries. By R. WATSON-JONES, B.Sc., M.Ch.Orth., F.R.C.S., Consultant in Orthopædic Surgery to the Royal Air Force; Director of Orthopædic and Accident Service, The London Hospital. Third edition. In two volumes. Vol. I. 9⅝ × 6⅝ in. Pp. 407 + xi, with 608 illustrations. 1943. Edinburgh: E. & S. Livingstone.

THE third edition of this work appears in two volumes and the author is to be congratulated on this improvement, as a volume of some 720 pages is too heavy to read in comfort in an arm-chair. The present first volume of the third edition is of handy size and contains just over 400 pages. The text has been thoroughly revised and many new illustrations have made their appearance. Several coloured pictures appear in this edition and are some of the finest that we have seen. The important problem of delayed union of fractures, which has come to the fore during this war, is dealt with in a masterly manner and this section alone makes the book of real value to all medical men, both in the Services and in civil practice, who have to deal with fracture cases.

This book still retains its place as the best volume so far written on the subject in the English language. The illustrations are very good indeed and include clinical, radiographic, and pathological pictures, as well as black and white drawings.

We should like to see more books of this type and style, for they enhance the prestige of British surgery.

War Wounds and Injuries. Edited by R. MAINGOT, F.R.C.S., E. G. SLESINGER, O.B.E., M.S., F.R.C.S., and ERNEST FLETCHER, M.A., M.B., M.R.C.P. With a Foreword by Lord HORDER. Second edition. 8⅜ × 5⅜ in. Pp. 499, with 119 illustrations. 1943. London: Edward Arnold & Co. 35s. net.

THE second edition of this book is published at an opportune moment, as doubtless many more war injuries will occur during the ensuing months, and it will be helpful to all surgeons who have to deal with traumatic surgery.

The hope expressed by Lord Horder in his foreword in 1940 that a chapter on burns would be included in subsequent editions has been realized. He also wished that a special chapter on "sepsis (other than gas gangrene) would be included". The editors rightly considered this unnecessary as 'sepsis' must be the main motif in every chapter of a book on war injuries.

The writer of the essay on "Anæsthesia in Warfare" even stresses its importance by pointing out that "the antibacterial properties of the sulphonamides are suppressed by all local analgesics containing the *p*-amino-benzoic acid grouping". This includes novocain, so these drugs should not be used if the wound is to be impregnated with sulphanilamide powder as a prophylactic against sepsis. He also stresses the stimulating effect of hypotonic alkaline solution containing potassium given per rectum in shock.

The chapter on sulphonamide therapy is particularly valuable and will be welcomed by all surgeons who find it difficult to keep abreast of the various

chemotherapeutic agents and their action and reactions. These drugs are so often used in a haphazard manner as they are 'fashionable', and it so often is a case of "pouring drugs of which we know little into bodies of which we know less".

Since the war there has naturally been a spate of war-wound literature, but the editors have shown a fine sense of discrimination in their selection of articles, excluding the meticulously small refinements in favour of great basic principles. For instance, they sum up the meaning of the term 'débridement' as meaning *revision*, i.e., "to examine with a view to correction".

In the article on burns, Dupuytren's six degrees are rightly replaced by two—partial and complete skin destruction. The conclusions arrived at for the treatment of burns are: "(1) Absence of sepsis throughout the treatment; (2) Early skin-grafting when there is total skin loss; (3) Prolonged after-treatment of the skin with lanolin (B.P.) to prevent keloid; (4) Use of superficial X-ray therapy in the treatment of early keloid or scar formation; (5) Early rehabilitation; and (6) Adequate follow-up so that late complications can be dealt with as soon as they arise".

The treatment of injuries to peripheral nerves has always been a great problem to the surgeon. Hilton, in his classical "Lectures on Rest and Pain" (1860), records a case where he prevented a naval officer giving up his commission after division of the right musculospiral nerve. He advised him to retain his commission as the probability was in favour of it being ultimately repaired. He records with a note of triumph, "I met him three years afterwards in Piccadilly when he flourished his stick in the air with his right arm and said he was ready for anything". He had taken two and a half years to recover. The difficulties of the problem are such that the editors were wise to devote eighty pages to "Peripheral Nerve Injuries" by the late Temp.-Lieut. W. Bremner Highet, R.A.M.C., who was drowned at sea on Feb. 11, 1943, while on service. All surgeons, and especially those interested in orthopædics, must have fully realized the sadness and wastefulness of war when they read the obituary notices of both Brigadier W. J. Eastwood, A.M.S., and Temp.-Lieut. Bremner Highet on the same page of the *British Medical Journal* (May. 22, 1943).

Bremner Highet was awarded the Jacksonian Prize of the Royal College of Surgeons in 1941 for his essay on "Injuries to Peripheral Nerves, with Special Reference to Late After-results", and which it was proposed should form the substance of two Hunterian Lectures. It embodied his work at the Peripheral Nerve Injury Centre at Oxford, where he was an assistant for the first three years of its existence, and the article in this book is an epitome of the methods of examination, recording, treatment, and after-care which have been developed there. It is the best description of the effects of these injuries and their treatment which has appeared in the language since the book by Sherren and Head. While it can be regarded as a worthy epitaph for the author, it whets the surgical appetite for an even more authoritative statement from this Centre when their observations are more complete.

No attempt can be made in a short review to criticize this article, but let it be said it should be read and re-read by all young surgeons, and those who are older will find in it satisfactory explanations of many of their own baffling cases of the past supported by carefully observed anatomical, physiological, pathological, and clinical data. It rightly stresses the fact that rehabilitation starts from the time of an injury and must not be left as a convenient dumping ground for surgical failures.

It is refreshing for an older surgeon to read in the article on injuries of the skull and brain that there is a great difference between the text-book classical description and the clinical experience of middle meningeal hæmorrhage, with the conclusion that "if the usual description were to be the basis of the diagnosis it would mean that many cases would fail to be diagnosed". It must always be suspected "in a patient in whom early traumatic recovery is followed by retrogressive changes", and "the deeper the focus of hæmorrhage the less the interval of lucidity". On the other hand, "chronic subdural hæmatoma must always be kept in mind when subjects with closed injuries of the head deteriorate after considerable intervals amounting to weeks or months".

A note of warning is sounded about the X-ray examination of the head in patients removed from bombed buildings. To prevent error the hair must first be cleansed of all debris or even shaved. Moreover, a thorough knowledge of the clinical state of the patient is necessary for the correct interpretation of the X-ray film. How often the clinical acumen of the radiologist should be appreciated by the surgeon and vice versa!

The best treatment of "The Spinal Bladder" obviously worried the author of the essay on spinal injuries. He satisfies himself by quoting authorities and giving no lead. In subsequent editions he may agree that an early suprapubic cystostomy will be the best soporific for the surgeon and at least leave the patient comfortable.

The treatment of chest injuries is becoming so crystallized as to enable the surgeon with little special experience at any rate to render intelligent first-aid treatment and to make a diagnosis of complications. "Bleeding into the pleura is always accompanied by an effusion poured out from the pleural surface . . . increase in volume of the hæmothorax is not necessarily evidence of continued bleeding. Estimation of the Hb percentage in the aspirated fluid is therefore essential". The converse is also true, viz., that accompanying atelectasis may mask the increase of the hæmothorax. The author doubts the efficacy of bronchoscopic aspiration in the treatment of atelectasis. This article is illustrated by a most useful series of radiographic illustrations, for which the publishers are to be congratulated and thanked.

The essay on abdominal injuries is an epitome of the Bradshaw Lecture delivered on Feb. 26, 1943, and has been published in this JOURNAL.

In a subsequent edition the article on wounds of blood-vessels would be enhanced by a discussion of arterial spasm. It is to be hoped that the advice given when discussing amputations is followed—namely, that if time allows, a consultation with surgical colleagues should always occur as a preliminary, and co-operation with the artificial limb-maker is very desirable.

The golden rule in the treatment of compound fractures is emphasized, viz.: "splint them where they lie", nor does the author favour any internal fixation by foreign bodies—a method being resuscitated in some American clinics.

In the article on gas gangrene no stress is laid on the fact urged in the M.R.C. memorandum that the condition is a clinical one rather than the mere presence of gas in the tissues. The incidence of gas gangrene has fortunately been comparatively rare so

far, probably due to the more thorough treatment of the wounds in the early stage. The author is satisfied that the administration of large doses of serum and treatment of the wound with Meleney's paste (zinc peroxide) is better than amputation.

The whole book is stimulating and eminently readable, the articles are well balanced, much being compressed into small space without the style being stilted. More editions must appear as experience widens. The early introduction of sulphanilamide powder into wounds should lengthen the safety interval for excision, as has been shown in the report on the 'Pearl Harbour' wounds, and lessen the occurrence of late complications.

The book will enable the war injury surgeon to concentrate on the essentials, and, using a modern Americanism, to "streamline his treatment" to the advantage of the wounded man and all concerned.

Endoscopic Prostatic Surgery. By ROGER W. BARNES, M.S., M.D., F.A.C.S., Professor of Clinical Urology, College of Medical Evangelists; Chief of Urology, White Memorial Hospital and Out-patient Clinic; Senior Attending Surgeon, Los Angeles County Hospital. 10 × 6⅞ in. Pp. 232, with 104 illustrations. 1943. London: Henry Kimpton. 30s. net.

THE use of endoscopic methods in the treatment of prostatic obstruction has become so popular that it was high time a book was produced from which all the relevant information could be obtained. Hitherto it could only be found after a lengthy perusal of the numerous articles on the subject in the current literature. Dr. Barnes has filled the gap with this volume, although he is the first to point out that the technique can only be learned under the supervision of an experienced operator and that reading is only a supplement to such practical work. The author prefers the Stern-McCarthy electrotome to the cold punch, but the book includes a chapter on the latter method written by one of its protagonists, Dr. H. C. Bumpus, jun. The urologist is left to choose for himself, but the indications and pre- and post-operative treatment are the same for both. All these points and many others are fully described and profusely illustrated. To the reader with some experience of endoscopic resection this book will prove a true guide; to him with none it may make the operation sound easier than is the case, and even the expert will learn something from it. The popular fallacy that median bars and bladder-neck contractures are all best treated by resection is exposed, and the surgeon is also discouraged from doing the operation unless he has perfected his technique and is working in an institution where he can give adequate supervision to the after-care. This book should certainly be in the possession of all who undertake this difficult branch of surgery.

Urology in General Practice. By NELSE F. OCKERBLAD, B.S., M.D., F.A.C.S., Professor of Clinical Urology, University of Kansas School of Medicine; etc.; and HJALMAR E. CARLSON, B.S., A.M., M.D., F.A.C.S., Instructor in Urology, University of Kansas School of Medicine; etc. 8 × 5⅝ in. Pp. 383, with 98 illustrations. 1943. Chicago: The Year Book Publishers Inc. (London: H. K. Lewis & Co.) 25s. net.

THIS book covers a wider field than its title would imply and includes much information which most general practitioners would be content to leave to the specialist. To one whose practice contains much urology it will prove a most useful aid. There are some ideas which will not find wide acceptance in this country; the preference for operative to conservative treatment in renal injuries is one, and the evidence drawn from one hundred consecutive cases from the literature is open to criticism. The chapter on renal tumours shows much better balance and first things are placed first. In a book which includes so many recent advances one is surprised to find that the only mention of mandelic acid is as a possible cause of hæmaturia; the authors evidently prefer the sulphonamides, which, indeed, receive a chapter to themselves as well as frequent references throughout the book.

The style is refreshing, and although much of the teaching is dogmatic this is evidently deliberate and it does something to provoke thought as well as to provide information. We can recommend this as a useful handbook to all interested in urology.

The Surgery of Repair. Injuries and Burns. By Squadron-Leader D. N. MATTHEWS, R.A.F.V.R., M.A., M.D., M.Ch., F.R.C.S., Surgical Specialist, Royal Air Force Volunteer Reserve; Surgical Officer-in-charge, R.A.F. Plastic Unit; Surgical Chief Assistant, Westminster Hospital, London; etc. 8¾ × 5½ in. Pp. 386 + xii, with 198 illustrations, several coloured. 1943. Oxford: Blackwell Scientific Publications Ltd. 45s. net.

THIS book covers briefly, but very adequately, a field of surgery which has hitherto received only scanty attention in this country. This neglect may be attributed to the inherent difficulties of teaching a subject which can only be demonstrated step by step from the time the injury is received through many stages to the final cure of the patient.

Every surgeon who is liable to be called upon to treat facial injuries, particularly those injuries which involve loss of tissue, should be aware of the principles enunciated here. The figure numbered 5, on page 18, showing the method of immediate repair of through-and-through losses of the mouth, cheek, nose, and mandible, is particularly excellent and illustrates the principle of 'accepting loss' which underlies the surgical treatment of all facial injuries with loss, but is not known as widely as it should be.

Discussing the diagnosis of depressed fractures of the malar-maxillary complex, the author gives obvious flattening of the normal contour of the cheek and palpation of the step deformity of the infra-orbital ridge, stating that these signs are soon masked by soft tissue swelling. It is all the more necessary, therefore, to comment on those signs and symptoms which are more constant. These are very palpable widening of the fronto-malar suture of the affected side; involvement of the infra-orbital nerve with consequent anæsthesia of the cheek and the upper incisors; and, very characteristically, pain on attempted mastication due to the muscular attachments to the malar, and sometimes to the fact that the depressed malar does not allow sufficient clearance to permit the subjacent coronoid process of the mandible to pass upward beneath it in the act of closing the jaw. Occasionally diplopia is mentioned as an urgent sign calling for reduction; unfortunately, as the author remarks, this is often masked by early swelling of the eyelids and is only noticed when the swelling subsides, by which time the bones are united in malposition.

Nor is stereoscopic X-ray as efficient in showing up these fractures as the method described by Dudley Stone, in which the patient's head is so positioned that the malars are 'thrown off'.

The chapter dealing with the repair of skin loss will be most useful; for here collected together in small compass is to be found a detailed description of the historic methods and the modern adaptations of these methods, clearly described and really beautifully illustrated.

Under the somewhat controversial subject of the treatment of burns, the author advocates the use of the Bunyan-Stannard envelope as a first-aid measure. Whilst this has many advantages, it has one great disadvantage for first-aid use, and that is that to render the proximal extremity of the bag watertight it has to be circumferentially attached to the skin of the limb by tapes. Now every burnt limb swells and even the slightest constriction encloses the swelling and is resented by the patient.

This timely book should have a place in the medical library of every ship and field hospital and every base hospital too, where the difficult problems with which it deals are each provided with a surgical solution which should not prove beyond the capacity of any operating surgeon to carry to a successful issue.

Minor Surgery. (The Practitioner Handbooks.) Edited by SIR HUMPHREY ROLLESTON, Bt., G.C.V.O., K.C.B., M.D., F.R.C.P., and ALAN MONCRIEFFE, M.D., F.R.C.P. With an Introduction by SIR ALFRED WEBB-JOHNSON, K.C.V.O., C.B.E., D.S.O., T.D. 8½ × 5½ in. Pp. 174 + xiv, with 30 illustrations. 1943. London: Eyre & Spottiswoode (Publishers) Ltd. for *The Practitioner*. 16s. net.

WHAT is Minor Surgery? Echo answers what! and this book will be searched in vain for an answer. Each contributor begins his essay with an apology for, rather than an elucidation of, the problem. The same question can be asked in the vernacular: "When does lamb become mutton?"

The book consists of a series of articles published by *The Practitioner* on Minor Surgery. The two physicians who edit it were wise in throwing the responsibility of the Introduction on to the President of the Royal College of Surgeons, in order, it is presumed, to elucidate and explain the meaning and scope of the title. Even he, however, with all the careful and lucid expression of thought in language with which his speeches and writings are always associated, does not succeed in satisfying himself or the reader.

His well-considered and weighty advice to the aspirant to minor surgical procedures is that like another procedure they are "not to be enterprised, nor taken in hand inadvisedly, lightly, or wantonly . . . but reverently, discreetly, advisedly and soberly", and also, as in this procedure, by carrying out what may be considered by some to be a minor intervention he "shoulders a major responsibility".

Some years ago it was not uncommon to meet a practitioner who liked "a bit a' surgery", and bitter it sometimes was both to the patient and operator. This type is now becoming rare, and if the precepts laid down in these articles are followed then the breed will rapidly become extinct.

The editors plunge the reader into the midst of difficult problems by putting 'Minor Wounds' as the first article. It is placed rightly so in the forefront of the battle and the treatment of wounds will be the surgeon's last problem as well.

It is the prick of the needle which often causes the major responsibility in its results for the surgeon. The 'normal' denizens of the skin, like the permanent guests in a residential hotel, give little trouble to the management. It is the chance visitor who happens to turn up unexpectedly who is the source of all the trouble. How often is this the plot of the best seller and 'record run' play! So it is with the surgery of the minor wound. It is for this reason that the author's treatment quite rightly is like the polypharmacy of old—if one procedure does not deal with the chance visitor, then another may, but at the same time he warns against meddlesome surgery. The whole article can be summarized, as indeed most of them can, by stressing the great principles underlying the treatment of wounds, viz.: rest, maintenance of blood-supply, and the prevention of infection.

It would, however, be interesting and instructive to see the results of Bove's method of dealing with the flexor tendons by keeping the severed ends in apposition for three weeks by means of metal transfixion pins, by which it is claimed "union is sound and the functional and anatomical results are excellent".

The various common injuries which the practitioner is likely to see are passed in review by various authorities. Those on the foot and hand should be especially useful, but it would be better probably to indicate the operations rather than to give a description which is just enough to encourage the novice without being sufficient to ensure a successful outcome. The fixation necessary to ensure bony ankylosis in the conservative operation for hammer-toe can be taken as an example. It would have been better perhaps to have boldly encouraged the 'minor' surgeon to fix the two bones in apposition under direct vision by means of a Kramer wire as an internal splint, than to advise him to fix them by skin splintage. It is wise advice to stress the importance of 'full anæsthesia' when searching for foreign bodies in the hand, and the importance of wounds caused by the indelible pencil.

In a book of this type the instructions should be given in great detail, e. g., it is unwise even to open a thrombotic pile under an anæsthesia induced by "a few minims of adrenaline 1–1000 drawn into a 2-c.c. syringe which is then filled with 2 per cent procaine"—the "few minims" may be more than sufficient for the major responsibility to be developed.

The warning that prolapsed piles may herald a cancer higher up is very apt, and also the importance of opening peri-anal and perirectal abscesses as soon as diagnosed rather than waiting for them to point.

It is refreshing to have authority declaring that for the only operation mentioned in the Bible "there is no better technique than that which is practised by Rabbi", but again it must be remembered there are Rabbis—and Rabbis. The basic principles laid down for wound healing must be obeyed. Every practitioner should carefully study the instructions on catheterization, there is a grim reason for regarding the catheter as often the curse of genito-urinary surgery.

The whole book is well worth reading by practitioner, surgical teacher, and student. If its precepts are followed and obeyed both the patient and 'minor' surgeon will be spared many restless hours, and though it may be galling to the surgeon it is well to leave the patient secure and satisfied in his final criticism of the results of surgery with his dictum: "Yes, doctor, I've always had good healing flesh".

Injuries of the Skull, Brain, and Spinal Cord (Neuro-Psychiatric, Surgical, and Medico-legal Aspects). By various authors. Edited by SAMUEL BROCK, New York University. Second edition. 9 × 6 in. Pp. 616 + x, with 78 illustrations. 1943. Baltimore: The Williams & Wilkins Co. (London: Baillière, Tindall & Cox). 38s. 6d. net.

A SECOND edition of this book is welcome. Dealing with the neuro-psychiatric, surgical, and medico-legal aspects of injuries of the central nervous system, it is a comprehensive compilation by twenty-three contributors, among whom are such well-known authorities in the United States as Charles Elsberg of New York, F. C. Grant of Philadelphia, Max Peet of Ann Arbor, and from this country, C. P. Symonds of London, and Ritchie Russell of Edinburgh. The new edition includes much new matter which has appeared since this book was first published three years ago. As examples we may quote various observations on gunshot injuries, electro-encephalography, and chemotherapy with the sulphonamides. In addition to extensive revision of the original chapters, there is a new one on the electro-encephalographic findings in head injuries—a field in which there is still much that is controversial and in which unanimity of interpretation is by no means established. The editor's original object of producing a book which would describe in detail the immediate and remote effects of injuries of the skull, brain, and spinal cord and their appropriate treatment, is well upheld in the present volume. To the surgeon the sections on subdural hæmorrhage, spinal cord injuries, and gunshot injuries of the brain and cord are of particular interest. For the most part there will be general agreement with the views expressed, but not all surgeons will concur with the immediate treatment of cerebrospinal rhinorrhœa by reparative transfrontal craniotomy; some will prefer, with the support of the sulphonamides to wait a few days for the spontaneous closure which takes place in certain cases. This book should continue to prove a valuable work of reference for neurologists generally and those who are interested in the surgical, pathological, and psychiatric aspects of head and spinal injuries.

A Practice of Orthopædic Surgery. By T. P. MCMURRAY, M.B., M.Ch., F.R.C.S. (Edin.), Professor of Orthopædic Surgery, Liverpool University; etc. Second edition. 8½ × 5½ in. Pp. 435 + viii, with 191 illustrations. 1943. London: Edward Arnold & Co. 30s. net.

THERE is little change in the second edition of this excellent introduction to orthopædics, apart from additional paragraphs on such topics as hallux valgus, ischiofemoral arthrodesis, and excision of the patella for recurrent dislocation. Nothing is said about rupture of intervertebral discs, nor in the discussion of sciatic scoliosis is the connexion between the two even mentioned. Whether they like it or not the general practitioner and the orthopædic surgeon are supposed to know something about the causes of sciatic pain; they will find no help here.

There are a number of errors that one hardly expects to find in a second edition. Perthes appears throughout as a Frenchman (Perthé), the names of Denis Browne and Freiberg are spelt incorrectly, and epiphysiodesis is called epiphysiolysis. Two radiographs (55 and 56 *d*) are upside down, though in other respects the illustrations have been considerably improved.

After careful perusal of both editions of this book, it is not easy to see in what respect the author's endeavours "to give the reader a description of the basic principles which underlie treatment in orthopædic surgery" have been any more successful than those of writers of other text-books on the subject. That there are basic principles was shown by another great Liverpool master—Hugh Owen Thomas—and many of them are clearly set out here. But it is a little disappointing that one of our ablest teachers has not allowed himself more liberty. Rare bone diseases, obscure and unimportant deformities, and descriptions of operations are still set out in a stereotyped manner. These things are only an encumbrance to the student, and Professor McMurray could, we believe, have said more about the mechanism of production of deformity, the essentials of diagnosis, and the principles of treatment which, if properly understood, make orthopædics one of the most rational and satisfying fields of surgical endeavour.

BOOK NOTICES

[*The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.*]

Medical Clinics on Bone Diseases. A Text and Atlas. By I. SNAPPER, M.D., formerly Professor of Medicine, Peiping Union Medical College, Peiping, China. 10⅞ × 8½ in. Pp. 225 + ix, with 30 Plates. 1943. New York: Interscience Publishers, Inc. (London: H. K. Lewis & Co. Ltd.). 67s. 6d. net.

Skin Grafting of Burns. Primary Care; Treatment; Repair. By JAMES BARRETT BROWN, M.D., Lieutenant-Colonel, Medical Corps, Army of the United States; Senior Consultant in Plastic and Maxillo-facial Injuries and Burns, E.T.O., U.S.A.; Associate Professor of Surgery, Washington University, St. Louis, Missouri; and FRANK MCDOWELL, M.D., Assistant in Clinical Surgery, Washington University, St. Louis, Missouri. 10 × 7 in. Pp. 204 + xii, with 131 illustrations. 1943. London: J. B. Lippincott Co. 30s. net.

Fractures and Dislocations for Practitioners. By EDWIN O. GECKELER, M.D., F.A.C.S. Third edition. 9 × 6 in. Pp. 361 + x, with 320 illustrations. 1943. Baltimore: The Williams & Wilkins Co. (London: Baillière, Tindal & Cox). 25s. net.

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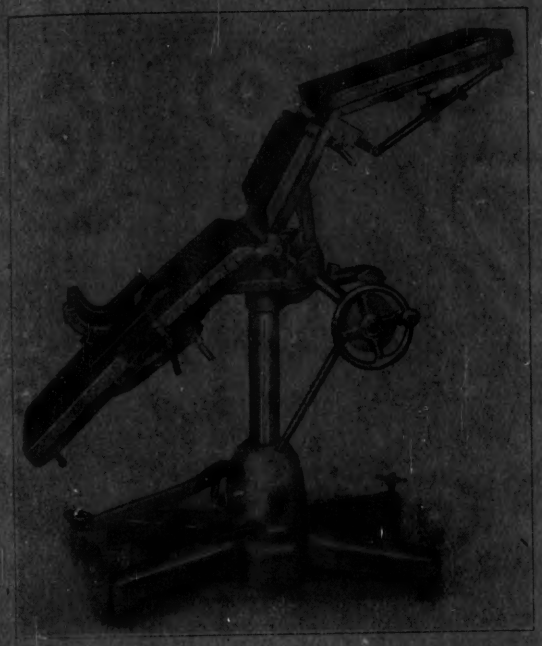

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